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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Technical Report 32-1581

*A Bibliography of the Theory and Application
of the Phase-Lock Principle*

*William C. Lindsey
University of Southern California*

*Robert C. Tausworthe
Jet Propulsion Laboratory*

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**JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA**

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Preface

The work described in this report was sponsored by the National Aeronautics and Space Administration, under Contract NAS 7-100, and by the Department of the Navy, Office of Naval Research, under Contract N00014-67-A-0269-0022. The National Aeronautics and Space Administration sponsorship was directed through the Telecommunications Division of the Jet Propulsion Laboratory.

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Abstract

Since much has been recorded on the phase-locked loop, a literature search was conducted in an effort to collect and compile as many references on the subject as possible. Although not all inclusive, this report presents a comprehensive listing of approximately 800 references covering the past two decades of work reported throughout the world. The compilation is given in two parts: first by categories, and then alphabetically by authors.

A Bibliography of the Theory and Application of the Phase-Lock Principle

I. Introduction

As the reader may be made aware by the mere weight of this report, the world has had much to say about the *phase-locked loop* over the past two decades. Several years ago, the authors decided to compile as many references on this subject as possible and list them both categorically and alphabetically into one report. The project sounded easy enough. A computer search of the literature generated a six-inch-thick printout of references that had been keyed to such words as "phase lock," "tracking systems," etc. The task remained, however, to first weed out those which did not appear to be appropriate, and then incorporate those with references which we had accumulated over the years, if not already included in the list.

But the more we stirred around in it, the more we found and the bigger the job got. Some references were missing page numbers, journal references, and were otherwise incomplete; others contained errors in the title, journal reference, date, etc. We have attempted to check as many sources as possible, but we know that we still do not have a complete set of references, that in the ones given here errors yet remain, and that some are still inadequate for the reader to locate the cited work.

Readers who detect omitted references or errors in the ones given or who can supply missing information in these references are requested to contact the authors so that the supplemental information can be incorporated into future updates of this report.

II. Listings by Categories

A. Books and Monographs

- Gardner, F. M., *Phaselock Techniques*, John Wiley & Sons, Inc., New York, 1966.
- Klapper, J., and Frankle, J. T., *Phaselocked and Frequency Feedback Systems*, Academic Press, Inc., New York, 1972.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.
- Lindsey, W. C., and Simon, M. K., *Telecommunication Systems Engineering*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1973.
- Shakhgildian, V. V., and Lyakhovkin, A. H., *Faxovaia Avlopodstoika Chasttoly*, Moscow, 1966.
- Tausworthe, R. C., *Theory and Practical Design of Phase-Locked Receivers: Volume I*, Technical Report 32-819, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 15, 1966.
- Viterbi, A. J., *Principles of Coherent Communications*, McGraw-Hill Book Co., Inc., New York, 1966.

B. Basic Theory

- Aetjen, R. M., *Cancellation of Doppler Frequency Shift (U)*, AD-404 428, Air Force Cambridge Research Laboratories, Bedford, Mass., Mar. 1963.
- Alexander, P. H., and Kalra, S. N., "Unlock Characteristics of a Phase-Locked Loop," *Proc. IEEE (Letters)*, p. 1138, 1965.
- Baghdady, E. J., "Theoretical Comparison of Exponent Demodulation by Phase-Locked and Frequency-Compressive Feedback Techniques," *IEEE International Convention Record*, Vol. 12, pp. 402-421, 1964.
- Baird, C. A., Jr., *A Dual-Mode Phase-Locked Loop*, Harry Diamond Laboratories, Washington, D. C., Sept. 30, 1965.
- Baird, C. A., Jr., "Modified Quasilinearization Technique for the Solution of Boundary-Value Problems for Ordinary Differential Equations," *J. Optimization Theory Appl.*, Vol. 3, No. 4, pp. 227-242, 1969.
- Bautin, N. N., "Qualitative Study of a Certain Equation of the Theory of Phase Automatic Frequency Control," *Prikladnaia Matematika I Mekhanika*, Vol. 34, pp. 850-860, Sept.-Oct. 1970 (translation).
- Benjaminson, A., "Phase-Locked Klystrons Simulate Doppler Radar," *Electronics*, pp. 44-46, Apr. 19, 1963.
- Bershtein, I. L., "On the Theory of Automatic Phase Control of Frequency," *Radio Eng. Electron. USSR*, Vol. 3, No. 2, pp. 410-414, 1958.
- Bozzoni, E., and Mengali, U., "Comparison Between the Oscillating Limiter and the First-Order Phase-Locked Loop," *Proc. IEEE*, Vol. 56, No. 11, p. 2094, Nov. 1968.
- Burnett, E. E., "K_u-Band Phase-Locked System," *Proc. Nat. Winter Conv. Mil. Electron.*, 1963.

- Burton, D. J., and Hebbert, R. S., *Third Order Phase Locked Loops*, Naval Ordnance Laboratory, White Oak, Md., Apr. 1969.
- Cahn, C. R., "Piecewise Linear Analysis of Phase-Lock Loops," *Trans. IRE*, SET-8, pp. 8-13, Mar. 1962.
- Cambi, E., "Some Remarks on the Phase-Lock Loop," *ITS Eldo Tech. Rev.*, Vol. I, No. 3, pp. 233-244, 1966.
- Cambi, E., *A Survey of the Phase-Lock Loop*, European Space Vehicle Launcher Development Organization, Paris, France, May 1966.
- Charles, F. J., and Larson, F. L., "Spacecraft Telemetry and Command," *ITS Supporting Res. Adv. Develop.*, pp. 339-353, Feb. 28, 1967.
- Costas, J. P., "Synchronous Communications," *Proc. IRE*, Vol. 44, pp. 1713-1718, Dec. 1956.
- Crow, R. B., and Tausworthe, R. C., *Practical Design of Third-Order Phase-Locked Loops*, Memo 900-450, Apr. 1971 (JPL internal document).
- De Bellescize, H., "La Reception Synchrone," *Onde Elec.*, Vol. 11, pp. 230-240, 1932.
- Develet, J. A., *Fundamental Sensitivity Limitations for Second-Order Phase-Lock Loops*, Report 8616-0002-NU-000, Space Technology Laboratory, Los Angeles, Calif., June 1961.
- Develet, J. A., Jr., *Fundamental Sensitivity Limitations for Second Order Phase-Lock Loops*, AD-416 683, TRW Space Technology Laboratories, Los Angeles, Calif., 1964.
- Eisenberg, B. R., "Gated Phase-Locked Loop Study," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-7, pp. 469-477, 1971.
- Enloc, L. H., and Rodda, J. L., "Laser Phase-Locked Loop," *Proc. IEEE*, Vol. 53, No. 2, pp. 165-166, 1965.
- Fath, G. R., *Functional Analysis of Phase Locked Loops*, Syracuse University, New York (microfilm).
- Gardner, F. M., *Phaselock Techniques*, John Wiley & Sons, Inc., New York, 1966.
- Gardner, F. M., Kent, S. S., and Dasenbrock, R. D., *Theory of Phaselock Techniques*, N66-10515, Resdel Engineering Corp., Pasadena, Calif., 1966.
- Golay, M. J. I., "Normalized Equations of the Regenerative Oscillator-Noise, Phase-Locking, and Pulling," *Proc. IEEE*, Vol. 52, pp. 1311-1330, 1964.
- Gupta, S. C., "Transient Analysis of a Phase-Locked Loop Optimized for a Frequency Ramp Input," *IEEE Trans. Space Electron. Telem.*, Vol. SET-10, pp. 79-84, June 1964.
- Gupta, S. C., and Sanneman, R. W., "Optimum Strategies for Minimum Time Frequency Transitions in Phase-Locked Loops," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-2, pp. 570-581, Sept. 1966.
- Gupta, S. C., and Solem, R. J., "Optimum Filters for Second- and Third-Order Phase-Locked Loop for FM Television," *IEEE Trans. Space Electron. Telem.*, Vol. SET-11, pp. 54-62, June 1965.

- Halliday, D., "A Review of Some Phase Locked Loop Theory," *Proc. International Communication Conference*, Montreal, Canada, pp. 3-2 to 3-8, 1971.
- Hammond, W. M., and Stewart, T. L., "A Model Distribution for a Hybrid Phase-Locked Loop," Report on the *3rd Asilomar Conference on Circuits and Systems*, Pacific Grove, Calif., Dec. 10-12, 1969, pp. 149-152.
- Hartl, P., "Das Prinzip des 'Phase-Locked Loop' und seine Anwendung in Nachrichten-Empfaengern fuer die Raumfahrt," *Raumfahrtforschung*, Vol. 6, pp. 55-64, 1966.
- Hirade, K., and Kuramoto, M., "Design of Phase Locked Loop with Time Delay," *ITS Electron. Commun. Lab. Technol. J.*, Vol. 19, No. 2, pp. 73-86, 1970.
- Holmes, J. K., "On a Solution to the Second-Order Phase-Locked Loop," *IEEE Trans. Commun. Technol.*, Vol. COM-18, No. 2, pp. 119-126, 1970.
- Huang, M. Y., and Stuber, F. M., *The Combline Filter and Phase-Lock Loop*, N70-34526, TRW Systems Group, Redondo Beach, Calif., May 1970.
- Jaffe, R., and Rechtin, E., "Design and Performance of Phase-Lock Loops Capable of Near-Optimum Performance Over a Wide Range of Input Signal and Noise Levels," *Trans. IRE*, Vol. IT-1, pp. 66-76, Mar. 1955.
- Janky, J. M., "Nomograms Simplify Phase-Lock-Loop Analysis," *Microwaves*, Vol. 9, pp. 52-55, 1970.
- Johnson, W. A., *A General Analysis of the False-Lock Problem Associated with the Phase-Lock Loop*, Aerospace Corp., El Segundo, Calif., Oct. 2, 1963.
- Jones, T. J., "Phase-Locked Loop Optimization Based Upon the Mean-Square Minimization of Error and Error Rate," *Mervin J. Kelly Commun. Conf.*, University of Missouri-Rolla, Oct. 1970.
- Kline, A. J., Jr., and Moore, W. C., "Concepts and Computational Techniques Used in the Design of Phase-Lock Circuits," *Proc. National Telemetry Conference*, Houston, Tex., Apr. 13-15, 1965.
- Labin, E., "Theory of Synchronization by Control of Phase," *Phillips Res. Rep.*, Vol. 4, pp. 291-315, Aug. 1949.
- Lawhorn, R., and Weaver, C. S., "The Linearized Transfer Function of a Phase Locked Loop Containing an IF Amplifier," *Proc. IRE*, Vol. 49, p. 1704, Nov. 1961.
- Lehan, F. W., "Telemetry and Information Theory," *Trans. IRE*, Vol. TRC-2, pp. 15-19, Nov. 1954.
- Lewis, P. H., and Weingarten, W. E., "A Comparison of Second, Third, and Fourth Order Phase-Locked Loops," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-3, pp. 720-727, July 1967.
- Lienard, J. C., "The Phase Lock Loop—Linear Phenomena," *Revue Technique Cecles/Coru*, Vol. 1, No. 2, pp. 205-237, 1969.
- Lindenlaub, J. C., and McGillem, C. D., *Theoretical and Experimental Studies of Sub-Optimal Second and Third Generation Self-Adaptive Binary Communication System*, Semiannual Report, Purdue University, Lafayette, Ind., Jan. 1-June 30, 1966.

- Lindenlaub, J. C., and Olsen, D. P., *A Study of the Extended Linear Range Phase Lock Loop*, Report TR-EE68-27, Purdue University, Lafayette, Ind., Aug. 1968.
- Lindsey, W. C., "Block Coding for Space Communications," *IEEE Trans. Commun. Technol.*, Vol. COM-17, pp. 217-225, 1969.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.
- Lindsey, W. C., and Charles, F. J., "A Model Distribution for the Phase Error in Second Order PLL's," *IEEE Trans. Commun. Technol.*, Vol. COM-14, pp. 662-664, Oct. 1966.
- Lindsey, W. C., and Simon, M. K., *Telecommunication Systems Engineering*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1973.
- Lindsey, W. C., and Tausworthe, R. C., "A Survey of Phase-Locked Loop Theory," *IEEE Int. Commun. Conf.*, Minneapolis, Minn., June 1967.
- Lindsey, W. C., and Weber, C. L., "On the Theory of Automatic Phase Control," chapter in *Stochastic Optimization and Control*. Also *Proceedings of an Advanced Seminar*, University of Wisconsin, Madison, Wisc., Oct. 2-4, 1967.
- Nielson, C. L., *Principles and Applications of Phase-Lock Detection in Phase-Coherent Systems*, Technical Note HTR 57-003, Hallamore Electronics Corp., Anaheim, Calif., Apr. 12, 1957.
- Nishimura, T., "On the A Priori Information in Sequential Estimation Problems," *IEEE Trans. Automat. Contr.*, Vol. AC-11, pp. 197-204, Apr. 1966.
- Phase-Locked Loop Study*, Phase I (June 15, 1961) and Phase II (Dec. 15, 1961) of Project 2-520-1202, Motorola, Inc., Military Electronics Division, Scottsdale, Ariz.
- Preston, G. W., "Basic Theory of Locked Oscillators in Tracking FM Signals," *Trans. IRE*, Vol. SET-5, pp. 30-32, Mar. 1959.
- Pullen, K. A., "A Theory of Frequency Tracking for Narrowband Communications," *6th Nat. Commun. Symp.*, Utica, N. Y., Oct. 1960, pp. 83-89.
- Rey, T. J., Bozzoni, E., and Mengali, U., "Comments on Comparison Between the Oscillating Limiter and the First-Order Phase-Locked Loop," *Proc. IEEE (Letters)*, Vol. 57, No. 4, p. 726, 1969.
- Sanneman, R. W., and Gupta, S. C., "Optimum Strategies for Minimum-Time Frequency Transitions in Phase-Locked Loops," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-2, pp. 570-581, 1966.
- Segrue, D. F., *The First Order Phase Locked Loop*, MS Project Report, Polytechnic Institute of Brooklyn, New York, June 1970.
- Splitt, F. G., "Design and Analysis of a Linear PLL of Wide Dynamic Range," *IEEE Trans. Commun. Technol.*, Vol. COM-14, pp. 432-440, 1966.
- Stephenson, J. M., *Analysis of Phase Locked Loops*, Western Development Laboratories WDLTR 1599, AD-448 450, Philco Corp., Palo Alto, Calif., Nov. 1961.
- Stewart, T. L., "Analysis of a Hybrid Phase-Locked Loop for Improved Phase Estimation," *Proc. 13th Midwest Symposium on Circuit Theory*, May 7-8, 1970.

- Stewart, T. L., *Analysis of a Hybrid Phase-Lock Loop*, N70-28432, NASA Electronics Research Center, Cambridge, Mass., June 1970.
- Stiffler, J. J., *Theory of Synchronous Communications*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1970.
- Summer, H. M., *An Analysis of the Effects of Differential Phase Feedback on a Type 2 Feedback Control System As Applied to Phase-Lock Receivers*, Technical Report No. 8, N66-85762, Elect. Eng. Dept., Auburn Res. Foundation, Auburn, Ala., June 15, 1965.
- Theoretical and Experimental Studies of Sub-Optimal Second and Third Generation Self-Adaptive Binary*, Semiannual Report, Purdue University, Lafayette, Ind., Jan. 1-June 30, 1969.
- Van Trees, H. L., *Detection, Estimation, and Modulation Theory*, Part I (1968) and Part II (1971), John Wiley & Sons, Inc., New York.
- Viterbi, A. J., "Phase-Lock Loop Systems," in *Space Communications*, pp. 123-142, McGraw-Hill Book Co., Inc., New York, 1963.
- Viterbi, A. J., *Principles of Coherent Communication*, McGraw-Hill Book Co., Inc., New York, 1966.
- Viterbi, A. J., "System Design Criteria for Space Television," *Brit. IRE*, Vol. 19, pp. 561-570, Sept. 1959.
- Weaver, C. S., "A New Approach to the Linear Design and Analysis of Phase-Locked Loops," *Trans. IRE*, Vol. SET-5, pp. 166-178, Dec. 1959.
- Weber, C. L., *A Unified Theory of Coherent Digital Systems Which Track Doppler Frequency*, Interim Technical Report, N71-11297, University of Southern California, Los Angeles, Oct. 1969.
- Zakheim, J., "Study of the Functioning of Phase-Lock Systems," *Inter-Electronique*, Vol. 21, pp. 28-32, Nov. 1966.

C. Nonlinear Theory

- Anderson, D. R., and Luh, Y. Y. S., "An Analysis of High Order Phase-Locked Loop Behavior in the Presence of White Noise," Digest of Technical Papers, *Int. Commun. Conf.*, Minneapolis, Minn., p. 139, June 1967.
- Benes, J., *Statistical Dynamic of Automatic Control System*, ILIFF Books, Ltd., 1967.
- Benes, V. E., "Ultimately Periodic Solutions to a Nonlinear Integrodifferential Equation," *Bell Syst. Tech. J.*, Vol. XLI, pp. 257-268, Jan. 1962.
- Booton, R. C., Jr., "The Analysis of Nonlinear Control Systems with Random Inputs," *Proc. Symposium on Nonlinear Circuit Analysis*, Polytechnic Institute of Brooklyn, New York, pp. 369-391, Apr. 1953.
- Britt, C. L., and Palmer, D. F., "Effects of CW Interference on Narrowband Second-Order Phase-Lock Loops," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-3, pp. 123-135, Jan. 1967.

- Carden, F. F., Merrill, M. D., Jones, T. J., and Martin, C. R., "The Non-Linear Transient Behavior of Second, Third and Fourth Order Phase-Locked Loops," Records of the 20th IEEE Annual Southwestern Conference and Exhibition, Houston, Tex., Apr. 17-19, 1968.
- Chalkley, H. B., *False Lock in Sampled-Data Phase Lock Loops*, University Microfilms, Virginia Polytechnic Institute, Blacksburg.
- Charles, F. J., *A Second Order Phase-Locked Loop Study*, TS No. 3341-65-3, Feb. 1966 (JPL internal document). Also M.S. thesis, Syracuse University, Sept. 1965.
- Charles, F. J., and Lindsey, W. C., "A Model Distribution for the Phase Error in Second-Order Phase-Locked Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-14, pp. 662-664, Oct. 1966.
- Chen, C., "An Analysis of Performance of Phase-Locked Loop Susceptible to Interference and Noise," Digest of Technical Papers, *IEEE Int. Commun. Conf.*, Philadelphia, Pa., pp. 212-213, June 1966.
- Cleland, L. L., "Experimental Results on Phase Locked Loops with Added Non-linearities," *Mervin J. Kelly Commun. Conf.*, University of Missouri-Rolla, Oct. 5-7, 1970.
- Cleland, L. L., *Improvement of Phase-Locked Loops by the Introduction of Non-linearities*, University Microfilms, Purdue University, Lafayette, Ind.
- Gill, W. J., "A Comparison of Binary Delay-Lock Tracking-Loop Implementations," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-2, pp. 415-424, July 1966.
- Goldstein, A. J., "Analysis of the Phase-Controlled Loop with a Sawtooth Comparator," *Bell Syst. Tech. J.*, pp. 603-633, Mar. 1962.
- Holmes, J., "A Simulation Study of the First Slip Times Versus the Static Phase Offset for First- and Second-Order Phase-Locked Loops," in *The Deep Space Network*, Space Programs Summary 37-58, Vol. II, pp. 29-32, Jet Propulsion Laboratory, Pasadena, Calif., July 31, 1969.
- Holmes, J. K., "First Slip Times Versus Static Phase Error Offset for the First- and Passive Second-Order Phase-Locked Loop," *IEEE Trans. Commun. Technol.*, Vol. COM-19, pp. 234-235, 1971.
- Holmes, J. K., "Stationary and Nonstationary Phase Distributions for the Practical Second-Order Phase-Locked Loop," in *Supporting Research and Advanced Development*, Space Programs Summary 37-49, Vol. III, pp. 297-300, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 29, 1968.
- Hussein, A. W., *Phase-Error Statistics and a Second-Order Phase-Locked Loop and Design of an Optimum Decision Unit for Space Communications*, University Microfilms, Virginia Polytechnic Institute, Blacksburg.
- Iceland, L., and Leon, J. B., *Improvement of Phase-Locked Loops by the Introduction of Nonlinearities*, Purdue University, Lafayette, Ind., 1968.
- Ku, Y. H., and Su, J. C. C., "Comparison of Variances Evaluated by Kolmogorov's and Volterra's Techniques," *Proc. IEEE*, Vol. 54, pp. 900-901, June 1966.
- La Frieda, J. R., "Transient Solutions of the Fokker-Planck Equation for a Class of First-Order Phase-Locked Loops," *Proc. 4th Hawaii International Conference on System Sciences*, University of Hawaii, Honolulu, pp. 471-473, Jan. 12-14, 1971.

- Layland, J. W., "On the Optimum Correlation Function for a First-Order Tracking Loop," in *Supporting Research and Advanced Development*, Space Programs Summary 37-50, Vol. III, pp. 284-289, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 30, 1968.
- Layland, J. W., "On Optimal Signals for Phase-Locked Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-17, pp. 526-531, 1969.
- Lindauer, C. M., *Nonlinear Behavior/Analysis and Simulation of Several Second-Order Random-Modulated Phase-Locked Loops*, University Microfilms, Virginia Polytechnic Institute, Blacksburg.
- Lindgren, A. G., Pinkos, R. F., and Berube, R. H., "Noise Dynamics of the Phase-Locked Loop with Signal Clipping," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-5, No. 1, pp. 66-76, 1969.
- Lindsey, W. C., "Investigation of Second-Order Phase-Locked Loops by Fokker-Planck Methods," in *Supporting Research and Advanced Development*, Space Programs Summary 37-30, Vol. IV, pp. 262-268, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1964.
- Lindsey, W. C., *Nonlinear Analysis and Synthesis of Generalized Tracking Systems*; Part I, USCEE317, Dec. 1968; Part II, USCEE342, Apr. 1969; University of Southern California, Los Angeles, Calif.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Chaps. 9, 10, 11, 12, 15, and 16, Prentice-Hall, Inc., Englewood Cliffs, N. J. 1972.
- Long, L. L., and Rutledge, R. B., "A Digital Computer Simulation for Comparative Phase-Locked Loop Analysis," *Proc. National Electronics Conference*, Chicago, Ill., Vol. 21, Oct. 25-27, 1965.
- Long, L. L., Rutledge, R. B., and Wallace, N. D., "A Simulation Study of Phase-Locked Loop Dynamics in the Presence of Noise," Vol. 2, papers presented at the *1966 Region Six Annual Conference*, Tucson, Ariz., Apr. 26-28, 1966.
- Magill, D. T., "Noise Theory of Tracking Cross-Correlators," *IEEE International Convention Record*, New York, Vol. 13, Part 2, pp. 158-167, Mar. 22-26, 1965.
- Martin, J. C., *Minimum Variance Estimates of Signal Derivatives—A Problem in Instrument Landing Systems*, N71-30241, Clemson University, S. C., Dec. 1970.
- Mayfield, W. W., "A Sequence Solution to the Fokker-Planck Equation," *Proc. Hawaii International Conference on System Sciences*, pp. 474-476, Jan. 12-14, 1971.
- Nag, B. R., "Locking Range of an Oscillator for Different Nonlinearities," *Trans. Amer. Inst. Elec. Eng.*, Part I, Vol. 79, pp. 134-136, 1960.
- Nishimura, T., "The Mean-Squared Deviation of a Phase-Locked Loop Having a Triangular S-Curve," in *Supporting Research and Advanced Development*, Space Programs Summary 37-31, Vol. IV, pp. 311-315, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 28, 1965.
- Pearce, J. L. R., *Optimum Reception of Digital FM Signals*, Queens University, Kingston, Ontario.
- Rhee, M. Y., Lindauer, C. M., and Gohain, P. K., "State Modeling of Phase-Locked Loops with Random Modulation and Additive Noise," *Mervin J. Kelly Commun. Conf.*, University of Missouri-Rolla, Oct. 1970.

- Shakhtarin, B. I., "A Critical Case in Phase-Lock Control," pp. 635-637, and "Desynchronization in a Phase AFC System," pp. 641-644, *Radio Eng. Electron. Phys.*, Vol. 13, No. 4, 1968.
- Simon, M. K., "Nonlinear Analysis of an Absolute Value Type of an Early-Late Gate Bit Synchronizer," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 589-596, 1970.
- Stiffler, J. J., "Communication Systems Development: On the Optimality of the Square-Wave Correlation Function for the First-Order Loop," in *Supporting Research and Advanced Development*, Space Programs Summary 37-43, Vol. IV, pp. 321-323, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 28, 1967.
- Stiffler, J. J., "On the Selection of Signals for Phase-Locked Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 239-244, 1968.
- Strom, T., *Approximation of the Probability Density Function of a Phase-Locked Loop*, Technical Report No. 45, Royal Institute of Technology, Stockholm 70, Sweden, July 1971.
- Thomas, E. F., *Investigation and Analog Simulation of the Type Two and Type Three Phase-Lock Loop*, AD-295096, Air Force Institute of Technology, Wright-Patterson AFB, Ohio, Dec. 1962.
- Van der Pol, B., "The Nonlinear Theory of Electric Oscillations," *Proc. IRE*, Vol. 22, pp. 1051-1086, 1934.
- Van Trees, H. L., "Functional Techniques for the Analysis of the Nonlinear Behavior of Phase-Locked Loops," *Proc. IEEE*, Vol. 52, pp. 894-911, Aug. 1964.
- Viterbi, A. J., "Phase-Locked Loop Dynamics in the Presence of Noise by Fokker-Planck Techniques," *Proc. IEEE*, Vol. 51, pp. 1737-1753, Dec. 1963.
- Wang, C. C., "An Exact Solution of Injection Phase-Locking," *ITC Proc.*, Washington, D. C., pp. 94-104, Sept. 15-17, 1969.
- Whitbeck, R. F., *Graphical Analysis of Nonlinear Systems*, Ph.D. dissertation, Cornell University, Ithaca, N. Y., 1964.

D. Acquisition

- Acampora, A., and Newton, A., "Use of Phase Subtraction to Extend the Range of a Phase-Locked Demodulator," *RCA Rev.*, Vol. 27, pp. 577-599, Dec. 1966.
- Acampora, A., and Newton, A., "The Use of Phase Subtraction for Increasing the Range of a Phase-Locked Loop," *Proc. National Electronics Conference*, Chicago, Ill., Vol. 23, Oct. 23-25, 1967.
- "Acquisition and Tracking System for Space Vehicles," *Space Commun. Technol.*, Vol. I, pp. 84-86, Philco Research Division, Nov. 29, 1960.
- Anderson, T. O., and Gallo, A. J., "Design for a Rapid Automatic Sync Acquisition System," *Instrument Society of America 13th National Aerospace Symposium*, San Diego, Calif., June 13-16, 1967.
- "Automatic Acquisition for Narrow Bandwidth, Phase-Locked, Reference Loops," in *The Deep Space Instrumentation Facility*, Space Programs Summary 37-21, Vol. III, pp. 61-62, Jet Propulsion Laboratory, Pasadena, Calif., May 31, 1963.

- Carden, F. F., Gilbert, A. L., and Osborne, W. P., "Phase Lock Loop Acquisition of an Angle Modulated Carrier," *Proc. National Aerospace Electronics Conference*, Dayton, Ohio, pp. 382-388, May 18-20, 1970.
- Chiang, C., *The Lock-In Range of an Automatic Phase Control System with Nonlinear Reactance-Tube Characteristic*, N69-11053, Air Force Systems Command (Foreign Technology Division), Wright-Patterson AFB, Ohio, Jan. 10, 1968.
- De Couvreur, G., and Ludwig, D., "A General Solution for the Shortest Acquisition Time in Type-II Phase-Lock Loops," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-4, pp. 639-640, 1968.
- Develet, J. A., *The Influence of Time Delay on Second-Order Phase-Lock Loop Acquisition Range*, Report No. 9332.6-9, Space Technology Laboratory, Inc., Los Angeles, Calif., Sept. 1962.
- Develet, J. A., Jr., "The Influence of Time Delay on Second-Order Phase-Lock Loop Acquisition Range," *Proc. International Telemetry Conference*, London, England, Sept. 23-27, 1963, Institution of Electrical Engineers (London), Vol. 1, pp. 432-437, 1963.
- Dorf, R. C., and Shaft, P. D., "Minimization of Communication-Signal Acquisition Time in Tracking Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 495-499, 1968. Also *Proc. National Electronics Conference*, Chicago, Ill., Vol. 23, pp. 588-592, 1967.
- Dorf, R. C., and Shaft, P. D., "Reduction of Communication Signal Acquisition Time Through Nonlinear Design," *Proc. National Electronics Conference*, Chicago, Ill., Vol. 23, Oct. 23-25, 1967.
- Fleischmann, H. H., and Leonhardt, R., *Pull-In Range of General Phase Lock Circuits with One Large Time Constant*, Report No. GA 7564, John Jay Hopkins Laboratory for Pure and Applied Science, Gulf General Atomic, San Diego, Calif., Dec. 1966.
- Frazier, J. P., and Page, J., "Phase-Lock Loop Frequency Acquisition Study," *IRE Trans.*, SET-8, pp. 210-227, Sept. 1962.
- Gilbert, A. L., and Osborne, W. P., "Phase Lock Loop Acquisition of a Carrier Modulated by a Single Sinusoid," *Technical Papers of the 22nd Annual Southwestern Conference and Exhibition*, Dallas, Tex., pp. 205-208, Apr. 22-24, 1970.
- Goldstein, A. J., and Byrne, C. J., "Pull-in Frequency of the Phase-Controlled Oscillator," *Proc. IRE*, Vol. 49, p. 1209, July 1961.
- Gumacos, C., "Analysis of an Optimum Sync Search Procedure," *IEEE Trans. Commun. Syst.*, Vol. 11, No. 1, pp. 89-99, Mar. 1963.
- Herold, W., "The Locking Behavior of a Phase-Locked Loop With a Sawtooth Comparator," *Archiv Fuer Elektronik Und Uebertragungstechnik*, Vol. 25, pp. 226-300, May 1971 (in German).
- Hiroshige, K., "A Simple Technique for Improving the Pull-In Capability of Phase-Lock Loops," *IEEE Trans. Space Electron. Telem.*, Vol. SET-11, pp. 40-46, Mar. 1965.
- Hummels, D. R., "Some Simulation Results for the Time to Indicate Phase Lock," *IEEE Trans. Commun. Technol.*, Vol. COM-20, No. 1, pp. 37-43, Feb. 1972.

- Kapranov, M. V., "Band of Entrainment Asymptotic Value in Phase Frequency Control," *Izvestia Vysshiku Uchebnykh Zavedenii, Radiofizika*, Vol. 11, No. 7, pp. 1028-1040, 1968.
- Kapranov, M. V., "Method of Calculating the Locking Range of a Phase Sensitive Automatic Frequency Control System," *Telecommunications*, Vol. 18, No. 8, pp. 13-22, Aug. 1963 (translation from Russian).
- Keblawi, P. S., "Probability Distribution of Time to Phase Lock for a Second-Order Phase-Locked Loop," *RCA Rev.*, Vol. 29, pp. 106-121, 1968.
- Koopman, B. O., "The Optimum Distribution of Searching Effort," *J. Oper. Res. Soc. Amer.*, Vol. 5, p. 613, 1957.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Chap. 10, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.
- Ludwig, D., "A General Solution for the Shortest Acquisition Time in Type-II Phase-Lock Loops," *IEEE Trans. (Letters)*, Vol. AES-4, pp. 639-640, 1968.
- Ludwig, D., *Study, Optimization, and Comparisons of the Acquisition Characteristics of Phase-Locked Loop Systems*, N68-38155, Aztec School of Languages, Inc., Acton, Mass., Oct. 1968 (NASA translation into English from a French thesis.)
- Maykova, T. P., "Pull-in Range of a PAFC System with Nonlinear Integrating Filter," *Telecommunications*, Vol. 23, No. 8, 1969.
- Meer, S. A., "Analysis of Phase-Locked Loop Acquisition—A Quasistationary Approach," Records of *IEEE International Convention*, New York, Vol. 14, Part 7, pp. 85-106, Mar. 21-25, 1966.
- Meer, S. A., "A Generalized Analysis for the Acquisition Time and Pull-In Range of Phase-Locked Loops," papers presented at the *Conference on Frequency Generation and Control for Radio Systems*, London, England, May 22-24, 1967.
- Nikitin, N. P., "Probability of Signal Acquisition by a Phase-Locked Oscillator System Operating in the Frequency Search Mode," *Radiotekhnika*, Vol. 8, pp. 696-703, Nov.-Dec. 1965 (in Russian).
- Oberst, J. F., "Generalized Phase Comparators for Improved Phase-Locked Loop Acquisition," *IEEE Trans. Commun. Technol.*, Vol. COM-19, pp. 1142-1148, Dec. 1971.
- Pervachev, S. V., "Lock In Range of Phase Synchronized A.F.C.," *Radio Eng. Electron. Phys.*, Vol. 8, No. 2, pp. 287-290, Feb. 1963.
- Robinson, E. M., *Acquisition Capabilities of Phase-Locked Oscillators in the Presence of Noise*, TTS No. R60DSD11, General Electric Co., Syracuse, N. Y., Sept. 1960.
- Robinson, E. M., and Woods, C. R., *Acquisition Capabilities of Phase-Locked Oscillators in the Presence of Noise*, Tech. Inform. Ser. No. R60 DSD 11, General Electric Co., Sept. 15, 1960.
- Robson, P. G., "The Pull-In Range of a Phase-Locked Loop," papers presented at the *Conference on Frequency Generation and Control for Radio Systems*, London, England, May 22-24, 1967.

- Sanneman, R. W., and Rowbotham, J. R., "Random Characteristics of the Type II Phase-Locked Loop," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-3, pp. 604-612, July 1967.
- Sanneman, R. W., and Rowbotham, J. R., "Unlock Characteristics of the Optimum Type II Phase-Locked Loop," *IEEE Trans. Aerosp. Navig. Electron.*, Vol. ANE-11, pp. 15-24, Mar. 1964.
- Schuchman, L., *Acquisition Time in a First Order Phase Lock Loop*, N70-35562, Bellcomm, Inc., Washington, D. C., July 10, 1970.
- Shaft, P. D., and Dorf, R. C., "Minimization of Communication-Signal Acquisition Time in Tracking-Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 495-499, June 1968.
- Shaft, P. D., and Dorf, R. C., "Reduction of Communications Signal Acquisition Time Through Nonlinear Design," *Proc. National Electronics Conference*, Vol. 23, pp. 588-592, National Electronics Conference, Inc., Oct. 1967.
- Shakhgildyan, V. V., "Pull-in Range of a PAFC System with Inertia in the Presence of Fluctuating Interference," *Telecommun. Radio Eng.*, Vol. 21, p. 73, Feb. 1967.
- Tausworthe, R. C., "Communications Systems Development: Acquisition and False-Lock Behavior of Phase-Locked Loops With Noisy Inputs," in *Supporting Research and Advanced Development*, Space Programs Summary 37-46, Vol. IV, pp. 226-234, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 31, 1967.
- Taylor, R. E., *Automatic Acquisition System for Phase-Lock Loop*, N69-21543, NASA Goddard Space Flight Center, Greenbelt, Md., Jan. 7, 1969.
- Viterbi, A. J., *Acquisition and Tracking Behavior of Phase Locked Loops*, External Publication No. 673, Jet Propulsion Laboratory, Pasadena, Calif., July 1959.
- Viterbi, A. J., "Acquisition and Tracking Behavior of Phase-Locked Loops," *Proc. Symposium on Active Networks and Feedback Systems*, Apr. 1960, Microwave Research Institute Symposia Series, Vol. X, pp. 583-619, Polytechnic Press, 1960.
- White, E. L. C., *The Pull-In Range of an A.P.C. Loop*, Report RK/94, EMI Research Laboratory, Middlesex, England, Nov. 1955.
- Woodbury, J. R., "Phase-Locked Loop Pull-In Range," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 184-186, correction: p. 495, 1968; comments: Vol. COM-17, pp. 89-90, 1969.

E. Stability

- Beery, W. M., *Frequency Stabilization of Frequency-Shift-Keyed Transmission (U)*, AD-459 332, National Bureau of Standards, Boulder, Colo., Feb. 1965.
- Benjaminson, A., "Phase-Locking Microwave Oscillators to Improve Stability and Frequency Modulation," *Microwave J.*, pp. 88-92, Jan. 1963.
- Benjaminson, A., "Phase-Locked Microwave Oscillator Systems with 0.1 cps Stability," *Microwave J.*, pp. 65-69, Dec. 1964.

- Bershtein, I. L., and Sibiriyakov, V. L., "Phase Stabilization of Microwave Oscillators," *Radio Eng. Electron., USSR*, Vol. 2, No. 7, pp. 184-185, 1957.
- Caldwell, J. J., Rose, B. E., and Sydnor, R., "Frequency Stability Requirements for Space Communications and Tracking Systems," *Proc. IEEE*, Vol. 54, pp. 231-236, Feb. 1966.
- Carden, F., and Stewart, I. A., "Some Solutions and Stability Criteria for the Phase Lock Loop Equation," *Mervin J. Kelly Commun. Conf.*, University of Missouri-Rolla, Oct. 1970.
- Compton, R. T., Jr., *The Effect of a Pure Time Delay on the Stability of a Phase-Lock Loop*, Interim Report, N66-26382, Ohio State University Research Foundation, Columbus, Ohio, Feb. 1966.
- De Russo, P. M., Michaels, L. H., and Tuel, W. G., Jr., *Design and Stability of Phase Locked Loops*, Final Report, Rensselaer Polytechnic Institute, Troy, N. Y., Dec. 1, 1964.
- Frenkel, G., "Oscillator Stability and the Second-Order Phase-Locked Loop," *IEEE Trans. Space Electron. Telem.*, Vol. SET-10, pp. 65-69, June 1964.
- Gardner, F. M., "Stability of a Simple Phase-Lock Loop," *Proc. IEEE*, Vol. 58, pp. 1953-1954, 1970.
- Graefe, P. W. U., and Loh, N. K., "Stability Criteria of Phase-Locked Loops," *Proc. 3rd Annual Allerton Conference on Circuit and System Theory*, University of Illinois, Monticello, Ill., Oct. 20-22, 1965.
- Holtzman, J. M., and Rue, A. K., "Regions of Asymptotic Stability for Phase-Lock Loops," *IEEE Trans. Space Electron. Telem.*, Vol. SET-10, pp. 45-46, Mar. 1964.
- Lindsey, W. C. *Synchronization Systems in Communication and Control*, Chaps. 4 and 10, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.
- Lyness, H. L., "Oscillator Stability in Phase-Locked Loops," *Electro-Technology*, Vol. 75, pp. 34-36, May 1965.
- Peter, M., and Strandberg, M. W. P., "Phase Stabilization of Microwave Oscillators," *Proc. IRE*, Vol. 43, pp. 869-873, July 1955.
- Rey, T. J., "Stability of an APC System for Frequency Division," *Proc. IEEE (Letters)*, Vol. 54, pp. 73-74, Jan. 1966.
- Sann, K. H., "Phase Stability of Oscillators," *Proc. IRE*, Vol. 49, pp. 527-528, Feb. 1961.
- Seay, T. S., *Short-Term Oscillator Stability Specifications for Phase-Locked Loops*, N68-26668, Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Apr. 29, 1968.
- Strandberg, P. M., "Phase Stabilization of Microwave Oscillators," *Proc. IRE*, Vol. 43, pp. 869-873, 1955.
- Van Trees, H. L., "A Lower Bound on Stability in Phase-Locked Loops," *Inform. Contr.*, Vol. 6, pp. 195-212, Sept. 1963.
- VCO Stability, Research Summary 36-3, pp. 52-53, Jet Propulsion Laboratory, Pasadena, Calif., June 15, 1960.

F. Threshold

- Abrams, B. S., Oberst, J. F., Berkoff, M., and Schilling, D. L., *Phase Locked Loop Threshold Investigations*, Report PIBMRI-1274-65, Polytechnic Institute of Brooklyn, New York, June 1965.
- Advanced Threshold Reduction Techniques Study*, First Quarterly Report, ADCOM, Inc., Cambridge, Mass., July 1–Sept. 30, 1964.
- Arndt, G. D., and Loch, F. J., "A Comparative Analysis of Frequency Modulation Threshold Extension Techniques," *Proc. International Conference on Communications*, San Francisco, Calif., Vol. 1, pp. 21-20 to 21-26, June 8–10, 1970.
- Bayless, J. W., and Gupta, S. C., "Threshold Extension Using Phase Lock Demodulator in a FM Feedback Loop," Records of NTC 68, *National Telemetering Conference*, Houston, Tex., Apr. 8–11, 1968.
- Bayless, J. W., Gupta, S. C., and Hummels, D. R., "Threshold Investigation of Phase-Locked Discriminators," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-4, pp. 855–863, 1968.
- Cafissi, R., "Design of Threshold-Extension Phase-Lock Demodulators for Satellite Communications Stations," *Alta Frequenza*, Vol. 39, pp. 1081–1096, 1970 (in Italian).
- Camp, J. A., "A Comparison of the Threshold Extension Capabilities of FMFB and Phase-Lock Demodulators Employed in FDM-FM Communication Systems," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 191–200, 1969.
- Develet, J. A., Jr., "An Analytic Approximation of Phase-Lock Receiver Threshold," *IEEE Trans. Space Electron. Telem.*, Vol. SET-9, pp. 9–11, Mar. 1963.
- Develet, J. A., Jr., "A Threshold Criterion for Phase-Lock Demodulator," *Proc. IEEE*, Vol. 51, pp. 349–356, Feb. 1963; correction: p. 580, Apr. 1963.
- Filippi, C. A., *Advanced Threshold Reduction Techniques Study*, N67-16668, ADCOM, Inc., Cambridge, Mass., Jan. 1967.
- Gupta, S. C., Bayless, J. W., and Hummels, D. R., "Threshold Investigation of Phase-Locked Discriminators," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-4, No. 6, pp. 855–863, 1968.
- Gutleber, F. S., *Threshold Extension Revisited*, X70-13813, Army Electronics Command, Fort Monmouth, N. J., Jan. 1970.
- Harrison, R., "Analysis of the Statistics and Threshold of the Phase-Lock Loop," *IEEE Proc.*, Vol. 116, No. 1, pp. 43–52, Jan. 1969.
- Heinemann, H. N., "Threshold Extension Applied to Single Channel FM Receivers," *Conf. Proc. 8th Int. Conv. Mil. Electron.*, Washington, D. C., Sept. 1964.
- Hess, D., "Comments on Threshold Investigation of Phase-Locked Discriminators," *IEEE Trans. (Correspondence)*, Vol. AES-5, pp. 877–878, 1969.
- Hoffman, E., and Schilling, D. L., "Threshold of the FMFB," *Proc. Int. Commun. Conf.*, Boulder, Colo., 1969.
- Layland, J. W., "An Optimum Squaring Loop Prefilter," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 695–697, 1970.

- Lindenlaub, J. C., and Urhan, J. J., *Threshold Study of Phase Lock Loop Systems*, Interim Technical Report, Purdue University, Lafayette, Ind., Dec. 1966. Also in *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 787-795, Dec. 1968.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Chaps. 9, 10, 11, and 12, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.
- Lindsey, W. C., "Threshold Characteristics in Phase-Locked Frequency Discriminators," in *Supporting Research and Advanced Development*, Space Programs Summary 37-28, Vol. IV, pp. 223-226, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 31, 1964.
- Loch, F. J., "Threshold Extension Techniques Using Impulse Noise Estimation," *Proc. National Electronics Conference*, Chicago, Ill., Vol. 25, pp. 545-549, Dec. 8-10, 1969.
- Martin, B. D., "Threshold Improvement in an FM Sub-Carrier System," *Trans. IRE*, Vol. SET-6, pp. 25-33, Mar. 1960; comments by J. J. Spilker in *Trans. IRE*, Vol. SET-7, p. 55, June 1961.
- Osborne, P. W., *Threshold Analysis of Phase Locked Loops*, N70-24407, University Microfilms, Polytechnic Institute of Brooklyn, New York, 1969.
- Osborne, P. W., and Schilling, D. L., *Threshold Analysis of Phase Locked Loops*, N69-30729, Polytechnic Institute of Brooklyn, Freeport, N. Y., 1969.
- Osborne, P. W., and Schilling, D. L., "Threshold Analysis of Phase-Locked-Loop Demodulators Using Most Likely Noise," *IEEE Trans. Commun. Technol.*, Vol. COM-19, pp. 31-41, 1971.
- Osborne, P. W., and Schilling, D. L., "Threshold Performance of Phase Locked Loop Demodulators," *Proc. International Conference on Communications*, Philadelphia, Pa., June 12-14, 1968.
- Ridgway, R., "A Method of Calculating Phase-Lock Threshold," *Proc. IEEE (Letters)*, Vol. 54, pp. 2024-2025, 1966.
- Ridgway, R. I., and Carter, J. E., "More Comments on the Phase-Locked Loop Threshold," *Proc. IEEE (Letters)*, Vol. 55, No. 8, pp. 1531-1533, 1967.
- Roland, W. F., et al., *Threshold Criterion for Phase-Locked Loop Design*, Technical Memo 59, Philco Western Development Laboratories, May 1963.
- Schilling, D. L., Abrams, B. S., Oberst, J. F., and Berkoff, M., "Phase Locked Loop Threshold," *Proc. IEEE (Letters)*, Vol. 53, p. 1673, 1965.
- Schilling, D. L., and Billig, J., *A Comparison of the Threshold Performance of the Frequency Demodulator Using Feedback and the Phase Locked Loop*, Report No. PIB MRI-1207-64, Polytechnic Institute of Brooklyn, New York, Feb. 28, 1964.
- Schilling, D. L., and Billig, J., "On the Threshold Extension Capability of the PLL and the FDMFB," *Proc. IEEE*, Vol. 52, pp. 621-622, 1964.
- Schilling, D. L., and Smith, B. M., "Comments on Phase-Locked Loop Threshold," *Proc. IEEE (Letters)*, Vol. 55, pp. 82-83, 1967.
- Smith, B. M., "Phase-Locked Loop Threshold," *Proc. IEEE (Letters)*, Vol. 54, pp. 810-811, 1966; comments: Vol. 55, pp. 82-83, 1967.

- Smith, B. M., "A Semi-Empirical Approach to the PLL Threshold," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-2, pp. 463-468, July 1966.
- Spilker, J. J., Jr., "Threshold Comparison of Phase-Lock, Frequency-Lock and Maximum-Likelihood Types of FM Discriminators," presented at the *IRE Wescon Conference*, San Francisco, Calif., Aug. 22-25, 1961.
- Threshold Extension in FM Receivers*, X70-70119, LTV Electrosystems, Inc., Dallas, Tex., Feb. 1968.
- Urhan, J. J., *Threshold Study of Phase Lock Loop Systems*, University Microfilms, Purdue University, Lafayette, Ind.
- Urhan, J. J., and Lindenlaub, J. C., "Effects of a Class of Phase Comparators on the Threshold and Lock Range of Phase Lock Loop Systems," *Proc. 3rd Int. Conf. Commun.*, Minneapolis, Minn., June 1967.
- Van Trees, H. L., *A Threshold Theory for Phase-Locked Loops*, Technical Report No. 246, Lincoln Laboratory, Massachusetts Institute of Technology, Aug. 22, 1961.
- Weaver, C. S., "Thresholds and Tracking Ranges in Phase-Locked Loops," *Trans. IRE*, Vol. SET-7, pp. 60-70, Sept. 1961.

G. Demodulator and Discriminator

- Acampora, A., *Advanced FM Demodulator*, RCA Quarterly Report, Jan. 1-Mar. 31, 1967.
- Acampora, A., and Tepfer, A., *Advanced FM Demodulator*, RCA Quarterly Progress Report, Oct. 1-Dec. 31, 1966.
- Arronson, G., Acampora, A., Frankle, J. T., Klapper, J., and McLaughlin, P. J., "Error Rates with Angular Feedback Demodulators," Records of NTC 68, *National Telemetry Conference*, Houston, Tex., Apr. 8-11, 1968.
- Bayless, J. W., and Gupta, S. C., "Status of FM Feedback in Communication Systems," *IEEE Trans. Aerosp. Electron. Syst.*, Supplement, Vol. AES-3, pp. 11-23, 1967.
- Biswas, B. N., "Compound AFC-APC FM Demodulators," *Proc. IEEE (Letters)*, Vol. 56, pp. 204-206, Feb. 1968.
- Biswas, B. N., "Phase Locked Loops in the Demodulation of AM and FM Signals," report in collaboration with Prof. J. H. Park for the University of Minnesota, 1970.
- Biswas, B. N., and Datta, G., "Tunable Compound Phase Locked Demodulators," *Proc IEEE (Letters)*, Vol. 55, pp. 2044-2045, Oct. 1967.
- Booton, R. C., Jr., "Demodulation of Wideband Frequency Modulation Utilizing Phase-Lock Technique," *Proc. National Telemetry Conference*, Vol. II, May 23-25, 1962.
- Breikss, I. P., "Digital FM Discriminator System," *Proc. International Telemetry Conference*, Los Angeles, Calif., pp. 257-278, Oct. 13-15, 1970.
- Cahn, R., and Viterbi, A. J., "Optimum Coherent Phase and Frequency Demodulation of a Class of Modulating Spectra," *IEEE Trans. Space Electron. Telem.*, Vol. SET-10, pp. 95-102, Sept. 1964.

- Camp, J. A., *A General Method of Coherent Demodulation with Applications*, N69-21997, Arizona University, Tucson, Ariz., 1968.
- Carassa, F., and Rocca, F., "Advances in Phase-Lock Demodulation," *Int. Commun. Conf.*, Boulder, Colo., pp. 12.9-12.4, June 1969.
- Carden, F. F., Davis, G. L., Kelly, L. R., and Osborne, W. P., *A Study of the Immunity of FM Discriminators to 2 π Frequency Impulses*, N69-13308, New Mexico State University, Las Cruces, N. M., 1968.
- Carden, F. F., Hintz, T. B., and Kelly, L. R., "The FDM Demodulating Characteristics of Non-linear Phase-Locked Loops," *National Telemetry Conference*, Houston, Tex., Apr. 8-11, 1968.
- Casson, W. H., and Hall, C. C., "New Phase-Tracking Demodulator Will Not Lock on Sidebands," *Electronics*, pp. 52-55, Feb. 8, 1963.
- Clarke, C. E., et al., *Phase-Lock Studies*, Vols. I and II, Philco Reports RPAG21-6-1 and 6-2, Apr., Aug. 1961.
- Clarke, C. E., Golay, J. J. E., and Urban, S. J., *Phase Lock Studies*, Vol. III, Philco Research Division, Blue Bell, Pa., Oct. 27, 1961.
- Costas, J. P., "Synchronous Detection of Amplitude-Modulated Signals," *Proc. Nat. Electron. Conf.*, Vol. 7, pp. 121-129, 1951.
- de Waal, J. J., *On the Establishment of Reference Signal of Partial Coherent Demodulation*, European Space Research Organization, Ph.D. Dissertation, Enchede, Netherlands, Feb. 1971.
- Dishington, R. H., "Diode Phase Discriminators," *Proc. IRE*, Vol. 37, pp. 1401-1404, Dec. 1949.
- Ellis, M. E., and Sage, G. F., "Optimum Control Loop Design for Synchronous FM TONE Demodulators," *Proc. 1966 National Telemetry Conference*, Boston, Mass., May 10-12, 1966.
- Frankle, J., Heinemann, H., and Newton, A., "Multiple-Loop Frequency-Compressive Feedback for Angle-Modulation Detection," *RCA Rev.*, Vol. 29, pp. 252-269, 1968.
- Frankle, J., Lefrak, F., Mehlman, S., and Newton, A., "Phase Locked FM Demodulator for 600 Channel FDM," *8th Conv. on Mil. Electron.*, Washington, D. C., Sept. 1964.
- Gagliardi, R. M., "Error Probabilities in PCM/FM with Phase-Lock Loop Discriminators," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-2, pp. 608-611, Sept. 1966.
- Gilchrist, C. E., *Design and Operations Handbook for Phase-Locked Loop Discriminator*, JPL Publication No. 127, Jet Propulsion Laboratory, Pasadena, Calif., May 30, 1958.
- Hannan, W., and Olson, T., "An Automatic Frequency Controlled Phase Shift Keyed Demodulator," *RCA Rev.*, Vol. 22, pp. 729-752, Dec. 1961.
- Heckert, G. P., *Design of Phase-Locked FM Demodulators for Maximum Sensitivity*, TR 102, Philco Western Development Laboratories (to be published).

- Heinemann, H., and Tepfer, A., *Study, Investigation, Design and Development of a Demodulator*, Quarterly Progress Report, Radio Corporation of America, New York, Sept. 1–Nov. 30, 1966.
- Hennick, R. P., "Use This Tan-Lock Demodulator," *Electronic Design*, Vol. 18, pp. 74–75, Dec. 6, 1970.
- Kapranov, M. V., "The Effect of the Form of the Phase Detector Characteristics on the Asymptotic Capture Bandwidth of Phase Automatic Frequency Control," *Radio Eng. Electron. Phys.*, Vol. 14, No. 5, pp. 714–717, May 1969.
- Lehan, F. W., and Parks, R. J., "Optimum Demodulation," *IRE Nat. Conv. Rec.*, Part 8, pp. 101–103, 1953.
- Leskovar, B., "Essential Nonlinearity of Phase-Sensitive Detector Characteristics," *IEEE Trans. Instrum. Meas.*, Vol. IM-18, pp. 81–87, June 1969.
- Leskovar, B., "Generalized Criteria of Characteristic Nonlinearity of Phase-Sensitive Detection Systems," *Proc. 3rd Hawaii Int. Conf. on Systems Sciences*, Honolulu, pp. 13–16, 1970.
- Leskovar, B., "Nonlinearity Minimums and Maximums of a Phase-Sensitive Detection System," *IEEE Trans. Instrum. Meas.*, Vol. IM-19, pp. 25–27, 1970.
- Leslie, C. B., and Williams, K. G., *Analysis of a Coherent Detection Lock-In System*, Naval Ordnance Laboratory, White Oak, Md., Mar. 8, 1966.
- Lindenlaub, J. C., and Urhan, J. J., "A Phase Lock Loop System with a Modulo $2n\pi$ Phase Detector," *ITS Theoretical and Experimental Studies of Sub-Optimal Second and Third Generation Self-Adaptive Binary Communication Systems*, pp. 10–14, Dec. 31, 1966.
- Lindenlaub, J. C., and Urhan, J. J., Jr., "The Effect of Phase Detector Characteristics on Phase Lock Loop Design Parameters," *International Symposium on Information Theory*, Los Angeles, Jan. 31–Feb. 2, 1966, Purdue University, Lafayette, Ind.
- Lindenlaub, J. C., and Urhan, J. J., Jr., "Experimental Results for Phase-Lock Loop Systems Having a Modified n th-Order Tanlock Phase Detector," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 787–795, 1968. Also *International Conference on Communications*, Minneapolis, Minn., June 12–14, 1967.
- Lindsey, W. C., "Frequency Demodulation," in *Supporting Research and Advanced Development*, Space Programs Summary 37-27, Vol. IV, pp. 198–204, Jet Propulsion Laboratory, Pasadena, Calif., June 30, 1964.
- Lindsey, W. C., "Optimum Frequency Demodulation," in *Supporting Research and Advanced Development*, Space Programs Summary 37-26, Vol. IV, pp. 227–234, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 30, 1964.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Chaps. 12 and 15, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.
- Luby, D. C., Gill, W. J., Ballard, E. J., and Spilker, S. S., *Demodulation of Angle-Modulated Telemetry Signals: Vol. 1. Advanced Demodulation Techniques*, AD 639 787; *Vol. 2. Review of Demodulation Methods*, AD 639 788, Aug. 1966.
- McKay, G. A., "An Extended Phase Detector for Phase-Locked Receivers," *Proc. IEEE Region III Convention*, Jackson, Miss., Apr. 17–19, 1967.

- McRae, D. D., "Phase-Locked Demodulation in Telemetry Receivers," *Proc. 1958 Nat. Symp. Telem.*, Miami Beach, Fla., Sept. 1958.
- Miller, B. J., and Kocsis, L. L., "Phase-Lock Demodulators," *National Electronics Conference*, Oct. 1962.
- Natali, F. D., and Walbesser, W. J., "Phase-Locked-Loop Detection of Binary PSK Signals Utilizing Decision Feedback," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-5, pp. 83-90, 1969.
- Nelson, W. L., "Phase-Lock Loop Design for Coherent Angle-Error Detection in the Telstar Satellite Tracking System," *Bell Syst. Tech. J.*, Vol. 42, pp. 1941-1976, Sept. 1963.
- Olsen, D. P., *Equivalence of PLL Systems and a Discriminator Followed by a Nonlinear Feedback Filter*, Purdue University, Lafayette, Ind., June 1967.
- Olsen, D. P., and Lindenlaub, J. C., "A Phase Lock Loop with an Extended Linear Range Phase Detector," *Mervin J. Kelly Commun. Conf.*, University of Missouri-Rolla, Oct. 1970.
- Ongano, D., and Rocca, F., "Microwave, Nearly-Optimum Phase-Lock Demodulator," *Alta Frequenza*, Vol. 35, No. 8, pp. 845-855, 1966.
- Osborne, P. W., and Schilling, D. L., "Expected Number of Spikes of Phase Locked Loop Demodulators," *ITC Proc.*, Los Angeles, Calif., Vol. 4, 1968.
- Proni, E., "FM Demodulator Employing an Injection Locked Oscillator," *Alta Frequenza*, Vol. 38, pp. 95-103, 1969.
- Rocca, F., "Some Properties of Optimum Unconditionally Stable Phase-Lock Demodulators," *Alta Frequenza*, Vol. 36, pp. 424-429, May 1967.
- Rue, A. K., and Lux, P. A., "Transient Analysis of a Phase Locked Loop Discriminator," *Trans. IRE*, Vol. SET-7, pp. 105-111, Dec. 1961.
- Runyan, R. A., "Factors Affecting Choice of Loop Filters in Phase-Locked Loop Discriminators," Paper 9-1, *Proc. Nat. Symp. on Space Electron. and Telem.*, 1959.
- Runyan, R. A., "Technique in the Application of Phase Lock Demodulators to Data Processing," Paper 9-3, *Proc. Nat. Telem. Conf.*, 1962.
- Safonov, V. M., "Influence of the Shape of the Sawtooth Characteristic of a Phase Detector on the Locking Range of a Phase-Locked Oscillator," *Radiotekhnika*, Vol. 24, pp. 76-80, June 1969.
- Sapp, D. H., *A Synchronous Detection System Utilizing a New Method of Frequency and Phase Control*, MS thesis, University of Pennsylvania, Philadelphia, Pa., June 1960.
- Sassler, M., "A Phase-Locked Demodulator for Multichannel Telephone Traffic from Satellites," *Proc. Nat. Electron. Conf.*, Vol. 20, pp. 481-485, 1964.
- Schanne, J., and Hannan, W., "Use of a Phase-Locked Oscillator in PSK Demodulators," *RCA Eng.*, Vol. 6, pp. 27-28, 1961.
- Schilling, D. L., "Intermodulation Distortion of a Phase Locked Loop Demodulator," *IEEE Trans. Commun. Technol.*, Vol. COM-15, pp. 222-228, Apr. 1967.

- Schilling, D. L., Billig, J., and Kermisch, D., "Error Rates in FSK Using the Phase Locked Loop Demodulator," *1st IEEE Annu. Commun. Conv.*, Boulder, Colo., June 1965.
- Schmueckle, W., *A Contribution for Optimization Demodulation of Disturbed Frequency Modulation Signals*, Technische Hochschule, Hannover, West Germany, 1967 (in German).
- Schmueckle, W., "Optimum Demodulation of Disturbed Frequency-Modulated Signals," *Nachrichtentechnische Zeitschrift*, Vol. 21, pp. 464-470, Aug. 1968.
- Schwartz, M., *Maximum A Posteriori Demodulation of Analogue-Type Signals Through Random Fading Media*, Polytechnic Institute of Brooklyn, New York, 1964.
- Spilker, J. J., Jr., and Magill, D. T., "The Delay-Lock Discriminator—An Optimum Tracking Device," *Proc. IRE*, Vol. 49, pp. 1403-1416, Sept. 1961.
- "Strong Signal Sideband Discriminator," in *The Deep Space Instrumentation Facility*, Space Programs Summary 37-22, Vol. III, pp. 38-43, Jet Propulsion Laboratory, Pasadena, Calif., July 31, 1963.
- Thomas, C. M., "Optimization of Phase-Lock Demodulator for Single-Channel Voice," *Proc. Int. Commun. Conf.*, Philadelphia, Pa., June 1966. Also *Micro-wave J.*, Vol. 10, No. 7, pp. 43-47, 1967.
- Thomas, C. M., "Study Charts Phase-Locked Demodulator Distortion in TV, Multichannel Telephony," *Commun. Designer's Digest*, pp. 34-38, 1969.
- Urhan, J. J., "Characteristics of a Suboptimum Phase-Lock Demodulator," *Proc. 6th Annual Allerton Conference on Circuit and System Theory*, Monticello, Ill., Oct. 2-4, 1968.
- Urhan, J. J., Jr., and Lindenlaub, J. C., "Experimental Results for Phase-Lock Loop Systems Having a Modified n th Order-Tanlock Phase Detector," *IEEE Trans. Commun. Technol.*, Vol. COM-16, No. 6, Dec. 1968.
- Vaughan, G. R., and Osborne, E., "Phase-Locked Phase Modulator," *Digest of Technical Papers, IEEE Int. Commun. Conf.*, pp. 206-207, June 1966.
- Viterbi, A. J., *Functional Design of Telemetry Discriminators*, Technical Memorandum 8-1, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 1958.
- Viterbi, A. J., and Cahn, C. R., "Optimum Coherent Phase and Frequency Demodulation of a Class of Modulating Spectra," *IEEE Trans. Space Electron. Telem.*, Vol. SET-10, pp. 95-102, 1964.
- Webb, J. A., "A Study in Demodulation Techniques," *Proc. Nat. Electron. Conf.*, 1961.
- Williams, W. J., "Selection of Phase Sensitive Detectors for Space Radar," *IEEE Trans. Aerosp. Navig. Electron.*, Vol. ANE-11, pp. 230-234, Dec. 1964.
- Wynn, W. D., *The Optimum Phase Demodulator for Interfering PM Subcarrier Signals*, Bellcomm, Inc., Washington, D. C.
- Yang, J. H., and Wolff, S. S., "A Phase-Locked Loop with Quasi-linear Phase Detector," *Proc. 9th Allerton Conference on Circuit and System Theory*, pp. 349-357, 1969.

Yates, F. F., *Phase-Lock Demodulation of Sinusoidal FM*, Aerospace Corp., El Segundo, Calif., Nov. 20, 1963.

Ziemer, R. E., *Experimental Comparison of Costas and PLL Demodulators in RFI Environments*, NASA Goddard Space Flight Center, Greenbelt, Md.

H. Performance

Becker, H. D., Chang, T. T., and Lawton, J. G., *Investigations of Advanced Analog Communications Techniques*, TR, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., Dec. 23, 1963–Dec. 23, 1964.

Billig, J., and Schilling, D. L., "A Comparison of the Threshold Performance of the Frequency Demodulator Using Feedback and the Phase Locked Loop," Record of the 1965 *International Symposium on Space Electronics*, Miami Beach, Fla., Nov. 2–4, 1965.

Bratt, P., *Pull-in Performance of First-Order Phase-Locked Loops*, Mitre Corp., Bedford, Mass., Feb. 1965.

Brown, L. R., *Experimental Determination of Signal-to-Noise Relationships in PCM/FM and PCM/PM Transmission*, Interim Report NASA N62-13483, Electro-Mech. Res., Inc., Sarasota, Fla., Oct. 20, 1961.

Cahn, C. R., and Nilsen, P. W., "Loss of Lock and Reacquisition Performance of Carrier Tracking Loops," *Proc. 4th Hawaii International Conference on System Sciences*, Honolulu, pp. 667–669, Jan. 12–14, 1971.

Choate, R. L., *Analysis of a Phase-Modulation Communication System*, JPL Progress Report PR-30-21, Jet Propulsion Laboratory, Pasadena, Calif., Oct. 8, 1959.

Choate, R. L., "Analysis of a Phase-Modulation Communications System," *Trans. IRE*, Vol. CS-8, pp. 221–227, Dec. 1960.

Choate, R. L., "Design Techniques for Low-Power Telemetry," Paper 3-1, *Proc. 1962 Nat. Telem. Conf.*, May 1962.

Choate, R. L., and Sydnor, R. L., "Design of PM Communication Systems," *Trans. IRE*, Vol. SET-8, pp. 117–123, June 1962.

Cobb, R. F., and Martin, A. R., "A Guide to Acquisition Receiver Selection Performance," *Microwave J.*, pp. 63–68, June 1968.

Feistel, C. H., and Gregg, W. D., *A Unified Performance Analysis of Adaptive and Self-Synchronizing Receiving Systems*, Texas University, Austin, Tex., Mar. 24, 1969.

Frankle, J., "Threshold Performance of Analog FM Demodulators," *RCA Rev.*, Vol. 27, pp. 521–562, Dec. 1966.

Frenkel, G., *The Performance of Carrier-Tracking Loops*, Report No. R-241303-1-2, prepared for the Defense Communications Agency by System Sciences Corp., under Contract No. DCA-100-67-C-0023, Mar. 15, 1967.

Greenhouse, S. C., "Degradation of the Performance of a First-Order Phase-Locked Loop Due to Interference," Records of *International Symposium on Electromagnetic Compatibility*, Anaheim, Calif., pp. 21–29, July 14–16, 1970.

- Hirade, K., Kondo, S., and Kuramoto, M., "Configuration and Performance of Phase Locked Loop Composed of Three Subloops," *ITS Electron. Commun. Lab. Tech. J.*, Vol. 19, No. 2, pp. 87-102, 1970.
- Jaffe, R., and Rechtin, E., "Design and Performance of Phase-Lock Loops Capable of Near-Optimum Performance Over a Wide Range of Input Signal and Noise Levels," *Trans. IRE*, Vol. IT-1, pp. 66-76, Mar. 1955.
- Jones, T. J., "Error Rate Minimization for Improved Phase-Locked Loop Damping Characteristics," Technical Papers of the *22nd IEEE Annual Southwestern Conference and Exhibition*, Dallas, Tex., pp. 449-452, Apr. 22-24, 1970.
- Klapper, J., Aaronson, G., Acampora, A., Frankle, J., and McLaughlin, P., "Error Rates with Angular Feedback Demodulators," *IEEE Nat. Telem. Conf.*, Houston, Tex., Apr. 1968.
- Lindsey, W. C., "Design and Performance of Block-Coded Communication Systems," *Proc. 1967 National Telemetry Conference*, San Francisco, Calif., May 16-18, 1967.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.
- Lindsey, W. C., and Simon, M. K., "The Effect of Loop Stress on the Performance of Phase-Coherent Communication Systems," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 569-588, 1970.
- Lindsey, W. C., and Simon, M. K., *Telecommunication Systems Engineering*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1973.
- Margolis, S. G., "The Response of a Phase-Locked Loop to a Sinusoid Plus Noise," *Trans. IRE*, Vol. IT-3, pp. 136-142, June 1957.
- Okkes, R. W., "Performance of Partially Coherent Binary Reception," *Proc. International Telemetry Conference*, Washington, D. C., pp. 492-504, Sept. 15-17, 1969.
- "A Phase-Locked Loop with Sideband Rejecting Properties," and "Sideband Lock Investigation," in *The Deep Space Instrumentation Facility*, Space Programs Summary 37-21, Vol. III, pp. 76-83, Jet Propulsion Laboratory, Pasadena, Calif., May 31, 1963.
- Preston, G. W., and Tellier, J. C., "The Lock-In Performance of an AFC Circuit," *Proc. IRE*, Vol. 41, pp. 249-251, 1953.
- Protonotarios, E. N., "The Effect of Phase Jitter on the Performance of a First-Order Phase-Locked Loop," *IEEE Trans. Commun. Technol.*, Vol. COM-18, No. 1, pp. 74-76, 1970.
- Protonotarios, E. N., "Pull-In Performance of a Piecewise Linear Phase-Locked Loop," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-5, No. 3, pp. 376-386, 1969.
- Rao, K. R., and Stewart, T. L., "Optimum Performance of a Hybrid Phase-Locked Loop," *Proc. 4th Hawaii International Conference on System Sciences*, University of Hawaii, Honolulu, pp. 672-674, Jan. 12-14, 1971.
- Sage, G. F., "Performance of Multilevel PCM," *IEEE Trans. Aerosp. Electron. Syst.*, Supplement, Vol. AES-2, pp. 353-361, July 1966.

- Samoilenko, I. I., "The Reliability of the Synchronization of an Auto Generator in the Presence of Modulated Oscillations," *Radio Eng. USSR*, Vol. 15, No. 7, pp. 61-68, 1960.
- Sampson, W. F., *Comparative Noise Performance of Phase-Lock and Pulse-Counting Discriminators*, Technical Note HTR 58-007, Hallamore Electronics Corp., Anaheim, Calif., Feb. 28, 1958.
- Shreve, R., "Techniques for Analyzing a Phase-Lock Communication System's Performance," *Trans. Saturn V/Apollo and Beyond*, National Symposium, Huntsville, Ala., Vol. 4, June 11-14, 1967.
- Simon, M. K., "On the Equivalence in Performance of Several Phase-Locked Loop Configurations," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 449-452, 1970.
- Stiffler, J. J., "On the Performance of a Class of PCM Bit Synchronizers," Records of NTC 69, *National Telemetry Conference*, Washington, D. C., pp. 67-70, Apr. 22-24, 1969.
- Suter, C. F., Jr., *Performance of a Combination Phase and Frequency Lock System*, Naval Ordnance Laboratory, White Oak, Md., Feb. 3, 1967.
- Sykes, R. A., Smith, W. L., and Spencer, W. J., "Performance of Precision Quartz-Crystal Controlled Frequency Generators," *Trans. IRE*, Vol. I-11, pp. 243-247, Dec. 1962.
- Tausworthe, R. C., "A Method for Calculating Phase-Locked Loop Performance Near Threshold," *Proc. 1966 National Telemetry Conference*, Boston, Mass., May 10-12, 1966.
- Tausworthe, R. C., "New Calculation of Phase-Locked Loop Performance," in *Supporting Research and Advanced Development*, Space Programs Summary 37-31, Vol. IV, pp. 292-300, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 28, 1965.
- Thomson, D. N., "Performance of the Self Cohered Detector," *5th Annu. Radar Symp.*, Willow Run Lab., University of Michigan, pp. 85-91, Jan. 1959.
- Victor, W. K., *Minimum Bandwidths of Phase Lock Loops Using Crystal-Controlled Oscillators*, Jet Propulsion Laboratory, Mar. 15, 1954.
- Warner, A. W., "Design and Performance of an Ultra Precise 2.5 Mc Quartz-Crystal Unit," *Bell Syst. Tech. J.*, Vol. 34, pp. 1193-1217, Sept. 1960.
- Yates, F. F., *Communication Link Performance*, N63-23576, Aerospace Corp., El Segundo, Calif., Aug. 1963.
- Zrubek, W. E., *Optimum Design of Communication Links with Noisy Phase Reference*, N69-13155, NASA Manned Spacecraft Center, Houston, Tex., Dec. 1968.

I. Tracking

- Anderson, T. O., and Lindsey, W. C., "Digital-Data Transition Tracking Loops," *Proc. International Telemetry Conference*, Los Angeles, Calif., pp. 259-271, Oct. 8-11, 1968.

- Breese, M., Colbert, R., Rubin, W., and Sferrazza, P., "Phase-Locked Loops for Electronically Scanned Antenna Arrays," *Trans. IRE*, Vol. SET-7, pp. 95-100, Dec. 1961.
- Brockman, M. H., Buchanan, H. R., Choate, R. L., and Malling, L. R., "Extra-terrestrial Radio Tracking and Communication," *Proc. IRE*, Vol. 48, pp. 643-655, Apr. 1960.
- Chadima, G. E., "Passive Satellite Tracking Radar Employing a 50% Duty Cycle and a Phase-Lock Receiver," *Proc. 1962 National Symposium on Space Electronics and Telemetry*, Oct. 1962.
- Cleland, L. L., and Leon, B. J., "Phase-Locked Loops for Large Signal Tracking," *Proc. 11th Midwest Symposium on Circuit Theory*, University of Notre Dame, Ind., May 13-14, 1968.
- Debey, A. L., and Richard, V. W., "The Doploc Dark Satellite Tracking System," *Proc. Army Science Conference*, West Point, N. Y., June 1962, Vol. 1, pp. 199-210, Sept. 1962.
- de Bey, L. G., "Tracking in Space by DOPLOC," *Trans. IRE*, Vol. MIL-4, pp. 332-334, Apr.-July 1960.
- Didday, R. L., and Lindsey, W. C., "Subcarrier Tracking Methods and Communication System Design," *IEEE Trans. Commun. Technol.*, Vol. COM-16, No. 4, pp. 541-550, 1968.
- Doppler Tracking Loop Optimization Study*, AD-408 920, Philco Corp., Palo Alto, Calif., Dec. 1962.
- Fujii, A., and Osatake, T., "FM Reception by a Parametric Tracking Filter," *Electron. Commun. Jap.*, Vol. 53, pp. 98-106, Jan. 1970 (translation).
- Hayre, H. S., "Doppler Tracking Radar Systems," *Electronics and Telecommunication Engineering Division, India*, Vol. 51, pp. 169-172, 1970.
- Heckert, J. P., *Study of the Phase-Locked Loop for Doppler Tracking (U)*, AD-287107, Philco Corp., Palo Alto, Calif., 1963.
- Huff, R. J., and Reinhard, K. L., "A Delay-Lock Loop for Tracking Pulsed-Envelope Signals," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-7, pp. 478-485, 1971.
- La Frieda, J. R., "Transient Analysis of Nonlinear Tracking Systems," *Proc. National Electronics Conference*, Chicago, Ill., Vol. 26, pp. 762-767, Dec. 7-9, 1970.
- Laughlin, C. R., Jr., *Diversity Locked Loop as an Optimum Tracking Combiner*, X63-11218, NASA Goddard Space Flight Center, Greenbelt, Md., 1962.
- Lee, S. Y., and Nelson, L. D., *Tracking Analysis of a First Order Phase-Locked Loop with Two Sinewaves Modulation*, N71-17473, Bellcomm, Inc., Washington, D. C., Jan. 1, 1971.
- Lindsey, W. C., "Hybrid Carrier and Modulation Tracking Loops," *Proc. International Conference on Communications*, San Francisco, Calif., Vol. 2, pp. 34-10 to 34-14, June 8-10, 1970.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.

- Lindsey, W. C., and Simon, M. K., "Data-Aided Carrier Tracking Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-19, pp. 157-168, 1971. Also *Symposium on Information Theory*, Noordwijk, The Netherlands, June 15-19, 1970.
- Lindsey, W. C., and Simon, M. K., *Telecommunication Systems Engineering*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1973.
- Mathison, R. P., "Tracking Techniques for Interplanetary Spacecraft," Paper 8-2, *Proc. 1962 Nat. Telem. Conf.*, May 1962.
- O'Sullivan, M. R., "Tracking Systems Employing the Delay-Lock Discriminator," *Trans. IRE*, Vol. SET-8, pp. 1-7, Mar. 1962.
- Rice, J. E., Jr., *Phase-Locked Tracking Filter*, Sylvania Electric Products, Inc., Mountain View, Calif., June 25, 1963.
- Riedel, E. G., Jr., *The Effect of Frequency Tracking, the Use of a Phase Lock Loop, and Predicted Tracking on Receiver Sensitivity*, AD-286920, Air Force Institute of Technology, Wright-Patterson AFB, Ohio, Aug. 1962.
- Robinson, L. M., "TANLOCK: A Phase-Lock Loop of Extended Tracking Capability," *Proc. 1962 Convention on Military Electronics*, Los Angeles, Calif., Feb. 7-9, 1962.
- Shaft, P., *Optimum Design of the Nonlinearity in Signal Tracking Loops*, Stanford Research Institute, Menlo Park, Calif., May 1968.
- Spilker, J. J., Jr., "Delay-Lock Tracking of Binary Signals," *IEEE Trans. Space Electron. Telem.*, Vol. SET-9, pp. 1-12, Mar. 1963.
- Stevens, R., and Brockman, M. H., *Design and Performance of Deep Space Tracking and Telemetry System*, JPL External Publication No. 629, Jet Propulsion Laboratory, Pasadena, Calif., May 1959.
- Weaver, C. S., "Designing a Phase-Locked Loop as a Doppler Tracker," *Proc. IRE*, Vol. 50, p. 1992, Sept. 1962.
- Weaver, C. S., "Increasing the Dynamic Tracking Range of a Phase-Locked Loop," *Proc. IRE*, Vol. 4, pp. 952-953, May 1960.
- Woodman, R., *A Narrow-Band Tracking Filter*, NASA Goddard Space Flight Center, Greenbelt, Md., Jan. 17, 1964.

J. Phase-Locked Receivers

- Balodis, M., "Laboratory Comparison of Tanlock and Phaselock Receivers," *Proc. National Telemetry Conference*, Los Angeles, Calif., June 2-4, 1964.
- Beers, G. L., "A Frequency-Dividing Locked-In Oscillator FM Receiver," *Proc. IRE*, Vol. 32, pp. 730-737, 1944.
- Bryan, J. W., *Carrier Reproduction in a Diversity Receiver*, N68-13879, NASA Goddard Space Flight Center, Greenbelt, Md., Oct. 1967.
- Bucy, R. S., Cheng, S. Y., and Mallinckrodt, A. J., *A Design Study for an Optimal Non-Linear Receiver/Demodulator*, N70-41881, Final Report, Electrac, Inc., Anaheim, Calif., Aug. 31, 1970.

- Cannon, L. E., Curtis, C. F., and Duncan, J. D., *FM Receiver Sensitivity Improvement Studies*, Quarterly Report, Montana State College, Bozeman, Mont., Feb. 15-Mar. 14 1967.
- Curtis, C. F., and Duncan, J. D., *FM Receiver Sensitivity Improvement Studies*, X70-76800, Final Report, Montana State College, Bozeman, Mont., July 1970.
- Daley, T. J., *Improved Phase Locked Loop Receiver*, NASA Tech Brief 68-10008, National Aeronautics and Space Administration, Washington, D. C., Jan. 1968.
- Develet, J. A., *Statistical Design and Performance of High-Sensitivity Frequency-Feedback Receivers (U)*, AD-408 639, Aerospace Corp., Los Angeles, Calif., May 1963.
- Gilchrist, C., Goldstein, R., and Mathison, R., *Telemetry Receiver*, NASA Tech Brief 70-10008, National Aeronautics and Space Administration, Washington, D. C., Aug. 1970.
- Hess, D. T., "Equivalence of FM Threshold Extension Receivers," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 746-748, 1968.
- Hoffman, L. A., *Receiver Design and the Phase Lock Loop*, Aerospace Corp., El Segundo, Calif., May 1963. (Booklet prepared for Electronics and Space Exploration Technical Lecture Series, sponsored by IEEE.)
- Johnson, R. S., and Smith, A. E., "A Digital Simulation of a Phase Locked Receiver in a Fading Multipath Environment," Records of the *IEEE 7th Annual Region III Convention*, Cocoa Beach, Fla., pp. S4-2P1 to S4-2P13, Nov. 18-20, 1968.
- "L-Band Ground Transmit-Receive System Used in the Transponder Helicopter Ranging Experiments," in *Deep Space Instrumentation Facility*, Space Programs Summary 37-18, Vol. III, pp. 53-64, Jet Propulsion Laboratory, Pasadena, Calif., Nov. 30, 1962.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.
- "Mod IV Planetary Radar Receiver, 2.388 Gc," in *The Deep Space Instrumentation Facility*, Space Programs Summary 37-21, Vol. III, pp. 49-61, Jet Propulsion Laboratory, Pasadena, Calif., May 31, 1963.
- Pullen, K. A., *The Dynamic Characteristics of Phase-Lock Receivers*, Report No. 1093, Ballistic Research Laboratories, Aberdeen Proving Ground, Md., Jan. 1960.
- Ruthroff, C. L., "Injection-Locked-Oscillator FM Receiver Analysis," *Bell Syst. Tech. J.*, Vol. 47, pp. 1653-1661, 1968.
- Sassler, M., and Surenian, R., "Communication Receiver for Satellite Ground Station," *Elec. Commun.*, Vol. 39, No. 1, pp. 89-97, 1964.
- Schrader, J. H., "A Phase-Lock Receiver for the Arraying of Independently Directed Antennas," *IEEE Trans. Anten. Prop.*, Vol. AP-12, pp. 155-160, 1964.
- Schwartz, L. S., "Phase-Lock for Aerospace Communications Receivers," *Space/Aeronautics*, pp. 71-75, Feb. 1962.

Tausworthe, R. C., *Theory and Practical Design of Phase-Locked Receivers: Volume I*, Technical Report 32-819, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 15, 1966.

Vehicle Tracking Receiver Design, N66-38787, Motorola, Inc., Scottsdale, Ariz., Aug. 3, 1966.

Viskanta, V. Z., "Compound Phase-Locked Loop Receiver," Records of NTC 69, *National Telemetry Conference*, Washington, D. C., pp. 247-253, Apr. 22-24, 1969.

Wolff, M. W., "Receiver Design Techniques Cuts Synchronization Time," *Electronics*, pp. 74-78, McGraw-Hill Book Co., Inc., New York, Feb. 1964.

K. AGC, AFC, and APC Systems

Antsibor, N. M., and Kurbatov, A. V., "Tuning Out False Lockings in Phase Regulated AFC Systems with Pulsed Phase Detectors," *Elektrosviaz'*, Vol. 24, pp. 44-51, Nov. 1970 (in Russian).

Aupperle, E. M., *Locked Instability and Forced Oscillations in Automatic Phase Control Systems*, Technical Report AD-463100, Cooley Electronics Laboratory, University of Michigan, Ann Arbor, Mich., Dec. 1964.

Baker, T. S., *Analysis of the Synchronization of an Automatic Phase Control System*, AD-610 691, Cruft Laboratory, Harvard University, Cambridge, Mass., Nov. 1964.

Banta, E. D., *Locked-In in APC Systems*, Report No. 38, Philco Mathematics Group, 1954.

Bautin, N. N., "Qualitative Study of a Certain Equation of the Theory of Phase Automatic Frequency Control," *Prikladnaia Matematika I Mekhanika*, Vol. 34, pp. 850-860, Sept.-Oct. 1970 (translation).

Bershtein, I. L., and Sibiryakov, V. L., "Automatic Phase Control of Microwave Oscillator Frequency," *Radio Eng. Electron. USSR*, Vol. 3, No. 2, pp. 415-418, 1958.

Bespalvo, E. S., and Kuleshov, V. N., "Synthesis of a Filtration and Correction Circuit for a Phase-Locked Automatic Frequency Control System, Which Separates a Sinusoidally Frequency-Modulated Signal from Noise," *Radioelektronika*, Vol. 11, pp. 324-331, Apr. 1968 (in Russian).

Biswas, B. N., "Capture Capability of Automatic Phase Control Circuits in a Noisy Environment," *Proc. 14th (Midwest) IEEE Symposium on Circuit Theory*, Feb. 1970.

Biswas, B. N., "Phase Following Behavior of an APC Circuit with Respect to an FM Signal Contaminated with Stationary Random Noise," *Indian J. Phys.*, Vol. 41, pp. 648-668, Dec. 1966.

Boyer, R., *Digital Control of a Second-Order Linear AFC System with a Large Time Delay*, N65-24984, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 30, 1962.

Byelov, L. A., et al., "Simultaneous Automatic Phase Frequency Control and Synchronization," *Radio Eng. Electron. Phys. USSR*, Vol. 11, No. 2, pp. 1885-1890, Dec. 1966.

- Clarke, K. K., Tepedelenlioglu, N., and Unkauf, M., "The Frequency Locked Loop," *ITS Microwave Res. Inst. Programs*, Nov. 1967.
- Evtyanov, S. I., and Snedkova, V. K., "Dependence of the Hold-In Range of a Phase Lock AFC System on the Characteristics of the Phase Detector with Proportional Plus Integral Filter," *Telecommun. Radio Eng.*, Part 2, Vol. 24, No. 4, 1969.
- Golay, M. J. E., "Automatic Frequency Control, *Proc. IRE (Correspondence)*, Vol. 40, p. 996, 1952.
- Ignatov, Iu. F., "Statistical Analysis of the Accuracy of Phase-Locked AFC," *Telecommun. Radio Eng.*, Part II—*Radio Eng.*, Vol. 23, pp. 86–92, 1968. Also *Radiotekhnika*, Vol. 23, pp. 36–44, Feb. 1968.
- Ignatov, Iu. F., and Shakhgildian, V. V., "Synchronization Failure in a Phase-Lock Automatic Frequency Control System," *Elektrosviaz'*, Vol. 21, pp. 17–22, June 1967 (in Russian).
- Ingham, W. E., *The Design of an APC Synchronizing Loop*, Report No. RW/8, EMI Research Laboratory, Hayes, Middlesex, England, Apr. 1956.
- Kapranov, M. V., "Asymptotic Method of Calculating the Lock-On Band of a Second-Order Phase-Locked Automatic Frequency Control with a Filter Containing a Nonlinear Capacitance," *Elektrosviaz'*, Vol. 23, pp. 30–40, 1969 (in Russian).
- Kapranov, M. V., "Noise Filtering and Phase Locked Automatic Frequency Control," *Radio Eng. Electron. USSR*, Vol. 1, 1956.
- Leek, R., "Phase-Lock AFC Loops," *Electron. Radio Eng.*, pp. 141–146, Apr. 1957, and pp. 177–183, May 1957.
- Loutit, J. A., and Story, R. F., "Flexible Phase Lock Frequency Control by Analysis Procedures," *Proc. 13th Annu. Symp. on Frequency Control*, Asbury Park, N. J., pp. 371–383, May 12–14, 1959.
- Nesvizhskii, Iu. B., "Pulse-Phase Locked Automatic Frequency Control," *Radiotekhnika*, Vol. 20, p. 36, Sept. 1965. Also *Telecommun. Radio Eng.*, Vol. 20, pp. 95–102, Sept. 1965 (translation).
- Nikitin, N. P., "Cut-off in Tracking in a Network of Phase Automatic Frequency Control," *Automat. Remote Contr.*, Vol. 26, pp. 669–674, Apr. 1965.
- Nikitin, N. P., "Filtration of Internal Noise by a Phase Automatic Frequency Control Circuit," *Radioelektronika*, Vol. 13, pp. 764–766, June 1970 (in Russian).
- Nikitin, N. P., "Probability of Signal Hold-In in a Phase-Locked AFC Frequency Search System," *Radiotekhnika*, Vol. 8, pp. 696–703, Nov.–Dec. 1965. Also *Soviet Radio Eng.*, Vol. 8, pp. 516–520, Nov.–Dec. 1965.
- Ordung, P. F., Gibson, J. E., and Shinn, B. J., "Closed Loop Automatic Phase Control," *Trans. AIEE*, Vol. 73, pp. 375–381, Sept. 1954.
- Petrishchev, V. I., "Synthesis of a Time-Optimal Phase-Locked AFC System," *Radiotekhnika*, Vol. 26, pp. 64–71, Feb. 1971 (in Russian).
- Rey, T. J., "Automatic Phase Control: Theory and Design," *Proc. IRE*, Vol. 48, pp. 1760–1771, Oct. 1960. Corrections in *Proc. IRE*, p. 590, Mar. 1961.

- Richman, D., "APC Color Sync for NTSC Color Television," *IRE Conv. Rec.*, Part 4, 1953.
- Schilling, D. L., "The Response of an Automatic Phase Control System to an FM Signal in the Presence of Gaussian Noise," *IEEE Int. Conv. Rec.*, Part 8, pp. 242-246, Mar. 1963.
- Schilling, D. L., "The Response of an Automatic Phase Control System to FM Signals and Noise," *Proc. IEEE*, Vol. 51, pp. 1306-1315, Oct. 1963.
- Schilling, D. L., *The Response of an Automatic Phase Control System to FM Signals and Noise*, Report PIBMRI-1040-62, N63-12322, Polytechnic Institute of Brooklyn, New York, June 1962.
- Schilling, D. L., and Schwartz, M., "The Response of an Automatic Phase Control System to FM Signals and Noise," *IRE Int. Conv. Rec.*, Part 8, pp. 111-121, Mar. 1962.
- Shakhgildian, V. V., "Determination of Capture Band of a Phase Lock AFC System When the Reference Signal Is Phase Modulated," *Radio Eng. Electron. Phys.*, Vol. 11, No. 10, 1965.
- Shakhgildian, V. V., "Statistical Dynamics of a Phase-Locked Automatic Frequency Control System," *Radiotekhnika*, Vol. 25, pp. 66-70, May 1970 (in Russian).
- Shakhtarin, B. I., "Filtering Ability of a Phase-Locked AFC System," *Telecommun. Radio Eng. USSR*, Part 1, Vol. 20, pp. 20-25, 1966.
- Shakhtarin, B. I., and Shchepkin, Yu. N., "Experimental Study of the Action of Fluctuation Noise on a Phase-Locked AFC System," *Telecommun. Radio Eng. USSR*, Part 1, Vol. 20, pp. 15-19, 1966.
- Shakhtarin, B. I., and Shishkin, V. I., "Signal Locking by a Phase-Locked AFC System in the Frequency-Search Mode," *Telecommun. Radio Eng., Part II—Radio Eng.*, Vol. 25, pp. 115-118, Jan. 1970.
- Shakhtarin, B. I., "Filtering Capacity of a Phase-Locked AFC System," *Elektrosviaz'*, Vol. 20, Apr. 1966. Also *Telecommun. Radio Eng., Part I—Telecommun.*, Vol. 20, pp. 20-25, Apr. 1966.
- Sizov, V. P., "Phase Lock Automatic Frequency Control System with a Phase Shifter in the Feedback Circuit," *Telecommun. Radio Eng.*, No. 1, p. 90, Jan. 1967.
- Sizov, V. P., "Stationary Regimes of Phase-Locked Automatic Frequency Control," *Elektrosviaz'*, Vol. 22, pp. 63-67, 1968.
- Tikhonov, V. I., "Phase-Lock Automatic Frequency Control Application in the Presence of Noise," *Automatika i Telemekhanika*, Vol. 23, No. 3, 1960.
- Victor, W. K., and Brockman, M. H., *The Application of Linear Servo Theory to the Design of AGC Loops*, JPL External Publication No. 586, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 22, 1958. Also *Proc. IRE*, Vol. 48, pp. 234-238, Feb. 1960.
- Wendt, K. R., and Fredenall, G. L., "Automatic Frequency and Phase Control of Synchronization in Television Receivers," *Proc. IRE*, Vol. 31, pp. 7-15, Jan. 1943.

L. Synchronization

- Anderson, T. O., and Hurd, W. J., "Digital Transition Tracking Symbol Synchronizer for Low SNR Coded Systems," Conference Records of *International Conference on Communications*, Boulder, Colo., pp. 20-1 to 20-8, June 9-11, 1969.
- Bakaev, Yu. N., "Study of Television Flywheel Synchronization System," *Radio Eng. Electron.*, Vol. 3, pp. 315-329, 1958.
- Bakaev, Yu. N., "Synchronization Properties of a Phase Type AGC of the Third-Order," *Radiotekhnika I Elektronika*, Vol. 10, pp. 926-929, June 1965 (translation).
- Bakaev, Yu. N., "Synchronizing Properties of a Third-Order Phase-Locked Oscillator System," *Radiotekhnika I Elektronika*, Vol. 10, pp. 1083-1087, June 1965 (in Russian).
- Baker, T. S., "Synchronization of Phase-Locked Loops," *NEREM Rec.*, Boston, Mass., pp. 44-45, Nov. 1964.
- Biswas, B. N., "Combination Injection Locking with Indirect Synchronization Technique," *IEEE Trans. Commun. Technol.*, Vol. COM-19, Aug. 1971.
- Biswas, B. N., "Harmonic Synchronization of Oscillators Revised," *IEEE Trans. Circuit Theory*, Nov. 1972.
- Biswas, B. N., "On the Injection Synchronized Oscillator," *Proc. IEEE (Letters)*, Vol. 54, p. 880, June 1966.
- Biswas, B. N., "Interrupted Wave Synchronization," *Indian J. Phys.*, Vol. 41, pp. 209-225, Mar. 1967.
- Biswas, B. N., "Locking Phenomena in Injection Synchronized Pulsed Oscillator," *Indian J. Phys.*, Vol. 40, pp. 244-252, May 1966.
- Biswas, B. N., "Locking Phenomena in Phase Locked Oscillators," *Indian J. Phys.*, Vol. 38, pp. 148-175, Mar. 1964.
- Biswas, B. N., "Pseudo-Indirect Synchronization," *Indian J. Pure Appl. Phys.*, Jan. 1972.
- Biswas, B. N., "R.M.S. Frequency Error of Injection Synchronized Oscillator," *IEEE Trans. Circuit Theory*, Nov. 1970.
- Celinski, O., Jelonek, Z. J., and Syski, R., "Pulling Effect in Synchronized Systems," *Proc. IEE (London)*, Vol. 101, pp. 50-52, 1954.
- Cessna, J. R., *Bit Error Rates and Transient Times for a Binary Digital Loop Bit Synchronizer in Additive White Gaussian Noise*, Iowa University, Iowa City, Ia., Aug. 1970.
- Couch, L. W., and Johnson, R. C., *The Analysis of Synchronized Oscillators by Use of Phase-Locked-Loops*, Summary Report, Florida University, Gainesville, Oct. 6, 1969.
- Dewan, E. M., "Harmonic Entrainment of Van der Pol Oscillations; Phaselocking and Asynchronous Quenching," *IEEE Trans. Automat. Contr.*, Vol. AC-17, No. 5, Oct. 1972.

- Dye, R. A., "Phase-Lock Loop Swept-Frequency Synchronization Analysis," Record of the 1965 International Symposium on Space Electronics, Miami Beach, Fla., Nov. 2-4, 1965.
- George, T. S., "Analysis of Synchronizing Systems for Dot-Interlaced Color Television," *Proc. IRE*, Vol. 38, pp. 124-131, Feb. 1951.
- Gruen, W. J., "Theory of AFC Synchronization," *Proc. IRE*, Vol. 41, pp. 1043-1048, Aug. 1953.
- Haag, J., "Sur les Oscillations Auto-Entretenues," *Comptes Rendus de l'Academie des Sciences (Paris)*, Vol. 199, pp. 906-909, 1934; "Sur l'Etude Asymptotique des Oscillations de Relaxation," *ibid.*, Vol. 202, pp. 102-104, 1936; "Sur la Theorie Des Oscillations de Relaxation," *ibid.*, Vol. 204, pp. 932-934, 1937; "Formules Asymptotiques Concernant les Oscillations de Relaxation," *ibid.*, Vol. 206, pp. 1235-1237, 1938.
- Hata, M., and Iwano, T., "Direct Regenerative Phase-Locked Loop—A New Carrier Synchronization System," *Electron. Commun. Jap.*, Vol. 52, pp. 15-24, Sept. 1969 (translation).
- Hayes, J. F., and Sergo, J. R., Jr., "Analysis and Simulation of a PN Synchronization System," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 676-679, 1970.
- Hughen, J. H., and Lee, J. S., "An Optimum Phase Synchronizer in a Partially Coherent Receiver," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-7, pp. 652-661, 1971.
- Ignatov, Iu. F., and Shakhgildian, V. V., "Synchronization Failure in a Phase-Lock Automatic Frequency Control System," *Elektrosvyaz'*, Vol. 21, pp. 17-22, June 1967 (in Russian).
- Jelonek, F. J., and Khanu, A. H., "Synchronized Oscillatory Systems with Non-uniform Gain in the Feedback Loop," *Proc. IEE (Brit.)*, Vol. 113, No. 11, pp. 1769-1774, 1966.
- Jelonek, Z. J., and Cowan, C. J., "Synchronized Systems with Time Delay in the Loop," *Proc. IEE*, Vol. 104, Part C, pp. 389-397, 1957.
- Jelonik, Z., Celinski, O., and Syski, R., "Pulling Effect in Synchronized Systems," *Proc. IEE (Brit.)*, Vol. 101, Part 4, pp. 108-117, 1954.
- Kaehler, W., *Investigation of Bit Synchronization Methods for Data Transmission Over Noisy Channels*, Standard Elektrik Lorenz A. G., Stuttgart, West Germany, Mar. 1968.
- Labin, E., "Theory of Synchronization by Control of Phase," *Phillips Res. Rep.*, Vol. 4, pp. 291-315, Aug. 1949.
- Lienard, A. M., "Oscillations Auto-Entretenues," *Proc. Third International Congress for Applied Mechanics*, Stockholm, Vol. 3, Part 3, pp. 173-177, Aug. 1930.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.
- Rey, T. J., *Effects of the Filter in Oscillator Synchronization*, Technical Report 181, Lincoln Lab., M.I.T., Lexington, Mass., May 1958.
- Richman, D., "DC Quadricorrelator: A Two Mode Sync System," *Proc. IRE*, Vol. 42, pp. 288-299, Jan. 1954.

- Roberts, C. A., and Vitenas, A., *A Study of the Synchronization of Two Oscillators*, N69-11063, Harry Diamond Laboratories, Washington, D. C., June 1968.
- Schlesinger, K., "Lock Oscillator for Television Synchronization," *Electronics*, Vol. 22, pp. 112-117, Jan. 1949.
- Selin, I., and Tuteur, F., "Synchronization of Coherent Detectors," *IEEE Trans. Commun. Syst.*, Vol. 11, No. 1, pp. 100-109, Mar. 1963.
- Shakhtarin, B. I., "Certain Characteristics of a Nonlinear Phase Synchronization System," *Radiotekhnika*, Vol. 26, pp. 96-99, Apr. 1971.
- Stiffler, J. J., "Coding and Synchronization—The Signal Design Problem," in *Advances in Communication Systems—Theory and Applications*, Vol. 3, pp. 117-148, 1968.
- Stiffler, J. J., "Phase-Locked Synchronization With Sinusoidal Signals," in *Supporting Research and Advanced Development*, Space Programs Summary 37-27, Vol. IV, pp. 208-212, Jet Propulsion Laboratory, Pasadena, Calif., June 30, 1964.
- Stiffler, J. J., "The Squaring Loop Technique for Binary PSK Synchronization," in *Supporting Research and Advanced Development*, Space Programs Summary 37-26, Vol. IV, pp. 240-246, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 30, 1964.
- Tikhonov, V. I., "Effect of Fluctuations on the Operating Accuracy of Synchronization Equipment," *Soviet Physics—Uspekhi*, Vol. 7, pp. 574-591, Jan.-Feb. 1965.
- Tikhonov, V. I., "Effect of Fluctuations Upon the Operational Precision of Synchronizing Systems," *Uspekhi Fizicheskikh Nauk*, Vol. 83, pp. 665-694, Aug. 1964.
- Tucker, D., "Carrier Frequency Synchronization," *Post Office Elec. Eng.*, Vol. 33, pp. 75-81, 1940.
- Tucker, D. G., "The Synchronization of Oscillators," *Electron. Eng.*, Vol. 16, pp. 26-30, June 1943.
- Williard, M. W., "Analysis of a System of Mutually Synchronized Oscillators," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 467-483, 1970.
- Zanadvorov, P. N., "On the Synchronization of Oscillators by Periodic Pulse Trains," *Radio Eng. Electron. USSR*, Vol. 3, No. 2, pp. 281-296, 1958.
- Zegers, L. E., "Common Bandwidth Transmission of Information Signals and Pseudonoise Synchronization Waveforms," *IEEE Trans. Commun. Technol.*, Vol. COM-16, No. 6, pp. 796-807, Dec. 1968.

M. Operation in Presence of Noise or Interference

- Berube, R. H., and Lindgren, A. G., "Noise Dynamics of a Phase-Locked Loop with Nonlinear Signal Processing," *Proc. 21st National Aerospace Electronics Conference*, Dayton, Ohio, pp. 399-402, May 19-21, 1969.
- Berube, R. H., Lindgren, A. G., and Pinkos, R. F., "Noise Dynamics of the Phase-Locked Loop with Signal Clipping," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-5, pp. 66-76, 1969.

- Biswas, B. N., "Interference Reduction in Second Order Injection Synchronized Oscillator," presented at the 60th Indian Science Congress, 1972.
- Charles, F. J., and Lindsey, W. C., "Some Analytical and Experimental Phase-Locked Loop Results for Low Signal-to-Noise Ratios," *Proc. 17th International Astronautical Congress*, Madrid, Spain, Vol. 1, Oct. 9-15, 1966. Also *Proc. IEEE*, Vol. 54, pp. 1152-1166, Sept. 1966.
- Chelyshev, K. B., "Effect of External Noise on a Phase-Locked Oscillator," *Automatika i Telemekhanika*, Vol. 24, No. 7, pp. 942-949, July 1962.
- Clapp, J. K., and Lewis, F. D., "A Unique Standard-Frequency Multiplier," *IRE National Convention Record*, Part 5, 1957.
- Clarke, J. M., Otero, R. J., and Wanbaugh, W. C., "Pulse Interference Effects in a Phase-Lock Loop," Records of the *11th Electromagnetic Compatibility Symposium*, Asbury Park, N. J., pp. 207-214, June 17-19, 1969.
- Collinet, J. C. R., Hines, M. E., and Ondria, J. G., "FM Noise Suppression of an Injection Phase-Locked Oscillator," *IEEE Trans. Microwave Theory Tech.*, Vol. MTT-16, pp. 738-742, 1968.
- Craft, R., Reamer, E. D., and Young, J. R., "Detection and Measurement of Cycle Skipping and Phase Offsets in Frequency Multiplying Phase-Lock Filters," in *IEEE New Links to New Worlds*, National Space Electronics Symposium, 1963.
- Davenport, W. B., Jr., "Signal-to-Noise Ratios in Band-Pass Limiters," *J. Appl. Phys.*, Vol. 24, pp. 720-727, June 1953.
- Dominiak, K. E., and Pickholtz, R. L., "Transient Behavior of a Phase-Locked Loop in the Presence of Noise," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 452-456, 1970.
- Edson, W. A., "Noise in Oscillators," *Proc. IRE*, Vol. 48, pp. 1454-1467, Aug. 1960.
- Edwards, K. A., Golubjatnikov, O., and Brady, D. J., "Transistor Phaselocked Oscillators," *AIEE Commun. Electron.*, pp. 1043-1051, Jan. 1959.
- Esposito, R., and Mullen, J. A., "Noise in Oscillators with General Tank Circuits," *IRE Conv. Rec.*, Part 4, pp. 202-208, 1961.
- Fey, L., Atkinson, W. R., Newman, J., and Malling, L., "Obscurities of Oscillator Noise," *Proc. IEEE*, Vol. 52, pp. 104-106 Jan. 1964.
- Frank, R. L., and Nick, R. W., "Interference Vulnerability of Phase-Lock Loops with Amplitude Limiting and Sampling," Records of *EASCON '69*, Washington, D. C., pp. 62-74, Oct. 27-29, 1969.
- Golay, M. J. E., "Monochromaticity and Noise in a Regenerative Electric Oscillator," *Proc. IRE*, Vol. 48, pp. 1473-1477, Aug. 1960.
- Goldstein, R., *The Minimization of Oscillator Noise*, Research Summary 36-14, pp. 61-63, Jet Propulsion Laboratory, Pasadena, Calif., May 1, 1962.
- Gray, R. M., and Tausworthe, R. C., "Frequency-Counted Measurements and Phase Locking to Noisy Oscillators," *IEEE Trans. Commun. Technol.*, Vol. COM-19, pp. 21-30, 1971.
- Grivet, P., and Blaquiere, A., "Non-Linear Effects of Noise in Electronic Clocks," *Proc. IEEE*, Vol. 51, pp. 1606-1614, Nov. 1963.

- Highleyman, W. H., and Jacob, E. S., "An Analog Multiplier Using Two Field Effect Transistors," *Trans. IRE*, Vol. CS-10, pp. 311-317, Sept. 1962.
- Ignatov, Iu. F., and Shakhgildian, V. V., "The Effect of Noise on the Accuracy of a Phase-Locked AFC System," *Elektrosviaz'*, Vol. 20, Mar. 1966. Also *Telecommun. Radio Eng., Part I—Telecommun.*, Vol. 20, pp. 32-38, Mar. 1966.
- Inose, H., Saito, T., and Shibuya, T., "Design of Multiple-Input Phase-Locked Oscillator in Mutually Synchronized System," *Electronics Letters*, Vol. 6, pp. 468-469, 1970.
- Jochen, P., "Injection-Locked Oscillators," *Nachrichtentechnische Zeitschrift*, Vol. 23, pp. 537-541, Oct. 1970.
- Keblawi, P. S., "Unlock Behavior of the Second-Order Phase-Locked Loop With and Without Interfering Carriers," *RCA Rev.*, Vol. 28, pp. 277-296, June 1967.
- Kurokawa, K., "Noise in Synchronized Oscillators," *IEEE Trans. Microwave Theory Tech.*, Vol. MTT-16, pp. 234-240, 1968.
- Leskovar, B., "Generalized Analysis of Phase-Sensitive Detection-Circuit Operating Characteristics at the Signal Detection in the Presence of Noise," *IEEE Trans. Instrum. Meas.*, Vol. IM-21, No. 1, pp. 15-24, Feb. 1972.
- Leskovar, B., "Phase-Sensitive Detector Nonlinearity at the Signal Detection in the Presence of Noise," *IEEE Trans. Instrum. Meas.*, Vol. IM-16, pp. 285-294, Dec. 1967.
- Liakhovkin, A. A., and Shakhgildian, V. V., "Filtering of a Monochromatic Signal by Phase-Locked Oscillator," *Elektrosviaz'*, Vol. 18, pp. 11-18, Apr. 1964 (in Russian).
- Lindsey, W. C., "Phase-Shift-Keyed Signal Detection with Noisy Reference Signals," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-2, No. 4, pp. 393-401, 1966.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.
- Lindsey, W. C., and Simon M. K., *Telecommunication Systems Engineering*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1973.
- Malling, L. R., "Phase-Stable Oscillators for Space Communications, Including the Relationship Between the Phase Noise, the Spectrum, the Short-Term Stability, and the Q of the Oscillator," *Proc. IRE*, Vol. 50, pp. 1656-1664, July 1962.
- McAlcer, H. T., "A New Look at the Phase Locked Oscillator," *Proc. IRE*, Vol. 47, pp. 1137-1143, June 1959; errata: Vol. 48, p. 1771, Oct. 1960.
- McMaster, R. L., *Design for a Subaudio Phase-Lock, Pulse-Tracking Oscillator*, Stanford University, Calif.
- Mullen, J. A., "Background Noise in Oscillators," *Proc. IRE*, Vol. 48, pp. 1467-1473, Aug. 1960.
- Natali, F. D., and Walbesser, W. J., "Interference Rejection in a Phase-Locked Loop With Decision Feedback," *Records of EASCON '68*, Washington, D. C., pp. 187-192, Sept. 9-11, 1968.
- Nevarez, J. R., "Phase-Lock Plots for Injection-Locked Oscillators," *Proc. IEEE*, Vol. 56, pp. 1617-1619, 1968.

- Nishimura, T., "Design of Phase-Locked Loop Systems With Correlated Noise Input," in *Supporting Research and Advanced Development, Space Programs Summary 37-26*, Vol. IV, pp. 234-240, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 30, 1964.
- Palka, F. M., "Measured FM Noise Reduction by Injection Phase Locking," *Proc. IEEE*, Vol. 58, pp. 155-157, 1970.
- Poynter, R. L., and Steffensen, G. R., "Tunable High Stability Microwave Oscillator," *Rev. Sci. Inst.*, Vol. 34, pp. 77-82, Jan. 1963.
- Radionov, Ia. G., "Optimization of Transfer Function and Noise Band of a Linear Model of a Tracking Filter in the Presence of Fluctuation Noise," *Radio Eng. Electron. Phys.*, Vol. 15, pp. 1716-1719.
- Rey, T. J., "Further on the Phase-Locked Loop in the Presence of Noise," *Proc. IEEE*, Vol. 53, pp. 494-495, 1965.
- "RF Voltage Controlled Oscillator Developments," in *Deep Space Instrumentation Facility, Space Programs Summary 37-15*, Vol. III, pp. 34-36, Jet Propulsion Laboratory, Pasadena, Calif., May 31, 1962.
- Rhee, M. Y., "New Discussion on Noise and Non-linear Effects in Telemetry Links," *Proc. National Electronics Conference*, Vol. 25, pp. 844-848, Dec. 8-10, 1969.
- Schulman, R. J., and Unkauf, M. G., "Experimental Signal/Noise-Ratio Comparison of the Second-Order Phase-Locked Loop and the Second-Order Frequency-Locked Loop," *Electronics Letters*, Vol. 4, pp. 585-586, 1968.
- Sherman, R. J., "Quadri-Phase-Shift-Keyed Signal Detection with Noisy Reference Signal," Records of *EASCON '69*, Washington, D. C., pp. 45-52, Oct. 27-29, 1969.
- Smith, B. M., *Some Aspects of Phase-Locked Loop Behavior in the Presence of Noise*, Ph.D. thesis, University of Adelaide, Australia, May 1968.
- Smith, P. G., *A Study of the Effects of Interference on Narrowband Phase Lock Loops*, Final Report, Research Triangle Institute, Durham, N. C., Oct. 15, 1965.
- Strandberg, M. W. P., "Noise Spectrum of Phase-Locked Oscillators," *Proc. IRE*, Vol. 48, pp. 1168-1169, June 1960.
- Stratonovich, R. L., "Oscillator Synchronization in the Presence of Noise," *Radio Eng. Electron.*, Vol. 3, No. 4, pp. 54-68, 1958.
- Tikhonov, V. I., "The Effect of Noise on Phase-Lock Oscillation Operation," *Automatika i Telemekhanika*, Vol. 22, No. 9, 1959.
- Tikhonov, V. I., "The Operation of Phase Automatic Frequency Control in the Presence of Noise," *Autom. Remote Contr.*, Vol. 21, No. 3, pp. 209-214, 1960.
- Viterbi, A. J., *The Effect of Sinusoidal Interference on Phase-Locked Loops*, JPL Section Report 8-583, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 16, 1959.

N. Oscillator and Frequency Multipliers

- Adler, R., "A Study of Locking Phenomena in Oscillators," *Proc. IRE*, Vol. 34, pp. 351-357, 1946.

- Anderson, T. C., and Merrill, F. G., "Crystal-Controlled Primary Frequency Standards: Latest Advances for Long-Term Stability," *Trans. IRE*, Vol. I-9, pp. 136-140, Sept. 1960.
- Atkinson, W. R., Fey, L., and Newman, J., "Spectrum Analysis of Extremely Low Frequency Variations of Quartz Oscillators," *Proc. IRE*, Vol. 51, p. 379, Feb. 1963.
- Barnard, R. D., "Variational Techniques Applied to Capture in Phase-Controlled Oscillators," *Bell Syst. Tech. J.*, Vol. 41, pp. 227-256, Jan. 1962.
- Biswas, B. N., "Phase Jumping Phenomena in Frequency Dividers," *Int. J. Electron.*, Vol. 29, pp. 161-164, Feb. 1970.
- Byrne, C. J., "Properties and Design of the Phase-Controlled Oscillator with a Sawtooth Comparator," *Bell Syst. Tech. J.*, Vol. 41, pp. 559-602, Mar. 1962.
- Couch, L. W., "A Study of a Driven Oscillator with FM Feedback by Use of a Phased-Locked-Loop Model," *IEEE Trans. Microwave Theory Tech.*, Vol. MTT-19, pp. 357-366, 1971.
- Davies, G. L., *A Narrow-Band Tracking Filter and Frequency Multiplier*, Technical Note TD 50, Royal Aircraft Establ., May 1960.
- Frank, J., Newton, A., and Pugliese, L., "Solid State, Phase-Locked, Tunable UHF Power Oscillator," *Proc. 10th Annual East Coast Conference on Aerospace and Navigational Electronics*, Baltimore, Md., pp. 3.3.2 to 3.3.2-8, Oct. 1963.
- Gunigal, T. E., and Santarpia, D. E., *A Digital Voltage-Controlled Oscillator for Phase-Locked Loops*, N68-24389, NASA Goddard Space Flight Center, Greenbelt, Md., May 1968.
- Pedersen, B. O., "Phase-Sensitive Detection with Multiple Frequencies," *Trans. IRE*, Vol. I-9, pp. 349-354, Dec. 1960.
- Real, R. R., "Direct Frequency Modulation of Crystal Controlled Transistor Oscillators," *IEEE Trans. Commun. Syst.*, Vol. CS-10, p. 459, Dec. 1962.
- Rechtin, E., *Design of Phase Lock Oscillator Circuits*, Section Report No. 8-566, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 7, 1957.
- Sakaroff, S., "Frequency-Controlled Oscillators," *Communications*, Vol. 19, No. 50, pp. 7-9, 1939.
- Shakhtarin, B. I., and Shishkin, V. I., "Signal Capture in a Phase-Locked Oscillator During a Frequency Search," *Radiotekhnika*, Vol. 25, pp. 74-79, Jan. 1970.
- Smith, W. L., "Miniature Transistorized Crystal-Controlled Precision Oscillators," *Trans. IRE*, Vol. I-9, pp. 141-148, Sept. 1960.
- Stratemeyer, H. P., "A Low-Noise Phase Locked-Oscillator Multiplier," *Interim Proc. Symp. on Definition and Measurement of Short-Term Frequency Stability*, NASA Goddard Space Flight Center, Greenbelt, Md., Part III, pp. 121-136, Dec. 1964.
- Tausworthe, R. C., "Minimizing VCO Noise Effects in Phase-Locked Loops," in *Supporting Research and Advanced Development*, Space Programs Summary 37-33, Vol. IV, pp. 287-289, Jet Propulsion Laboratory, Pasadena, Calif., June 30, 1965.

Van der Pol, B., "Forced Oscillations in a Circuit with Nonlinear Resistance," *Philosophical Magazine*, Vol. 3, pp. 65-80, Jan.-June 1927.

Van der Pol, B., "Relaxation Oscillations," *Philosophical Magazine*, Vol. 2, pp. 978-992, July-Dec. 1926. Also see "Frequency Demultiplication," *Nature*, Vol. 120, pp. 363-364, Sept. 1970.

Vaughan, G. R., Osborne, E. F., and Entwistle, G. S., *Locked Oscillator Phase Modulator*, Appendix D, Final Report, N65-29140, Defense and Space Center, Westinghouse Elec. Corp., Baltimore, Md., Aug. 25, 1964.

Victor, W. K., *The Evaluation of Phase-Stable Oscillators for Coherent Communication Systems*, JPL External Publication No. 337, Jet Propulsion Laboratory, Pasadena, Calif., May 8, 1956.

Walker, J. R., and Overlander, R., *Oscillator, Phase-Locked*, AD-462 369, Space and Inform. Syst. Div., North American Aviation, Inc., Downey, Calif., Apr. 1964.

O. Cycle Slipping

Attwood, S., and Kline, A. J., *Phase-Locked Loop Frequency Control and the Dropout Problem*, NASA Tech Brief 68-10130, National Aeronautics and Space Administration, Washington, D. C., Apr. 1968.

Bozzoni, E. A., Marchetti, G., Mengali, U., and Russo, F., "An Extension of Viterbi's Analysis of the Cycle Slipping in a First-Order Phase-Locked Loop," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-6, pp. 484-490, July 1970.

Charles, F. J., and Lindsey, W. C., "Some Analytical and Experimental Phase-Locked Loop Results for Low Signal-to-Noise Ratios," *Proc. 17th International Astronautical Congress*, Madrid, Spain, Vol. 1, Oct. 9-15, 1966. Also *Proc. IEEE*, Vol. 54, pp. 1152-1166, Sept. 1966.

Hess, D. T., "Cycle Slipping in a First-Order Phase-Locked Loop," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 255-260, 1968. Also *ITS Microwave Res. Inst. Programs*, Nov. 1967.

Hess, D. T., and Schwartz, B., "Cycle Slipping in a Second Order Phase Locked Loop," *ITS Microwave Res. Inst. Programs*, Nov. 1967.

Holmes, J., "A Simulation Study of the First Slip Times Versus the Static Phase Offset for First- and Second-Order Phase-Locked Loops," in *The Deep Space Network*, Space Programs Summary 37-58, Vol. II, pp. 29-32, Jet Propulsion Laboratory, Pasadena, Calif., July 31, 1969.

Klapper, J., and Creutz, J., "Minimization of Cycle Slipping Rate in a First Order PLL with Frequency Offset," *3rd Asilomar Conference on Circuits and Systems*, Pacific Grove, Calif., Dec. 1969.

Lindsey, W. C., "Nonlinear Analysis of Generalized Tracking Systems," *Proc. IEEE*, Vol. 57, No. 10, pp. 1705-1722, Oct. 1969; also see *Synchronization Systems in Communication and Control*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.

- Sanger, D., and Tausworthe, R. C., "Digital Communication and Tracking; An Experimental Study of the First-Slip Statistics of the Second-Order Phase-Locked Loop," in *The Deep Space Network*, Space Programs Summary 37-43, Vol. III, pp. 76-80, Jet Propulsion Laboratory, Pasadena, Calif., Jan. 31, 1967.
- Sanneman, R. W., and Rowbotham, J. R., "Unlock Characteristics of the Optimum Type II Phase-Locked Loop," *IEEE Trans. Aerosp. Navig. Electron.*, Vol. ANE-11, pp. 15-24, Mar. 1964.
- Schuchman, L., "Time to Cycle Slip in First and Second Order Phase Lock Loops," *Proc. International Conference on Communications*, San Francisco, Calif., pp. 34-1 to 34-9, June 8-10, 1970.
- Shaft, P. D., and Dorf, R. C., "Maximization of the Mean Time to Loss of Lock," *Proc. First Asilomar Conference on Circuits and Systems*, Pacific Grove, Calif., pp. 387-396, Nov. 1-3, 1967, published by Western Periodicals Co.
- Smith, B. M., "The Phase-Lock Loop with Filter: Frequency of Slipping Cycles," *Proc. IEEE*, Vol. 54, pp. 296-297, Feb. 1966.
- Tausworthe, R. C., "Asymptotic Formula for Mean Cycle-Slip Time of Second-Order Phase Locked Loops with Frequency Offset," *IEEE Trans. Commun. Technol.*, to be published.
- Tausworthe, R. C., "Communication Systems Development: Cycle Slipping in Phase-Locked Loops," in *Supporting Research and Advanced Development*, Space Programs Summary 37-42, Vol. IV, pp. 200-205, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1966.
- Tausworthe, R. C., "Cycle Slipping in Phase-Locked Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-15, pp. 417-421, June 1967.
- Tausworthe, R. C., "Simplified Formula for Mean Cycle-Slip Time of Phase-Locked Loops with Steady-State Phase Error," *IEEE Trans. Commun. Technol.*, Vol. COM-20, No. 3, pp. 331-337, June 1972.
- Urhan, J. J., Jr., "Cycle-Slipping Effects on the Output Signal of a Phase-Locked Demodulator," *Proc. IEEE (Letters)*, Vol. 56, No. 1, pp. 80-81, 1968.
- Urhan, J. J., Jr., *Cycle Slipping and FM Signal Distortion for a Class of Phase Lock Loops*, N70-29778, Notre Dame University, Ind., Feb. 23, 1970.
- Viterbi, A. J., "Phase-Locked Loop Dynamics in the Presence of Noise by Fokker-Planck Techniques," *Proc. IEEE*, Vol. 51, pp. 1737-1753, Dec. 1963. Also in *Principles of Coherent Communications*, McGraw-Hill Book Co., Inc., New York, pp. 96-103, 1966.
- Young, J. R., Reamer, E. D., and Craft, R., "Detection and Measurement of Cycle Skipping and Phase Offsets in Frequency Multiplying Phase-Lock Filters," *IEEE Nat. Space Electron. Symp.*, p. 14, 1963.

P. Applications

- Aein, J. M., *Coherency Criterion for the Binary Symmetric Channel*, N69-31221, Institute for Defense Analysis, Arlington, Va., Mar. 1969.
- Arnold, J., and Leclercq, M., "Measurements of Phase and Amplitude with the Aid of Phase-Locked Filters," *l'Echo Rech.*, pp. 70-75, Apr. 1966.

- Artym, A. D., "The Applications of a Phase Automatic Frequency Controller," *Radio Eng. USSR*, Vol. 13, No. 8, pp. 48-59, 1958.
- Baghdady, E. J., and Marshall, A. C., *FM Improvement Techniques*, Final Report, N63-22119, ADCOM, Inc., Cambridge, Mass., Feb. 1, 1963.
- Biswas, B. N., "An Improvement in the Technique of Time Measurement," *Indian J. Phys.*, July 1967.
- Biswas, B. N., "On the Performance of Automatic Phase Control Circuit," presented at the *Symposium on Electronics and Telecommunications*, Calcutta University, Feb. 27-28, 1964.
- Biswas, B. N., "Phase Locked Pulsed Oscillators," *Indian J. Pure Appl. Phys.*, Aug. 1967.
- Biswas, B. N., "Phase Locking Method of Measuring Dielectric Constant," *J. Sci. Instrum.*, Vol. 44, p. 557, July 1967.
- Biswas, B. N., "A Tracking Loop for the Apollo Unified S-Band Communication System," presented at the 60th Indian Science Congress, 1972.
- Burnham, F., and Sandler, M., "The Lock-Lock Loop," Records of the *National Telemetry Conference*, Washington, D. C., pp. 228-232, Apr. 12-15, 1971.
- Crafts, C. A., "Phase Multilock Communication," *Conf. Proc. 2nd Nat. Conv. on Mil. Electron.*, Washington, D. C., pp. 262-265, June 1958.
- Fralick, S., Mumma, J., and Develet, J., *The Analysis of Advanced Synchronous Telemetry Techniques (U)*, Final Report, AD-631 857, TRW Space Technol. Labs., Los Angeles, Calif., Oct. 1961.
- Gardner, F. M., "DOPLOC Uses Phase-Locked Filter," *Electronic Industries*, Vol. 18, pp. 96-99, Oct. 1959.
- Gee, T. H., *An Analytical and Experimental Investigation of a Frequency-Shift-Keyed Signal Generated by a Phase-Locked-Loop with Application to Narrow-band FSK*, University Microfilms, Virginia Polytechnic Institute, Blacksburg, Va.
- Gilchriest, C. E., *The Application of Phase-Locked Loop Discriminators for Threshold Improvement and Error Reduction in FM/FM Telemetry*, JPL External Publication No. 364, Jet Propulsion Laboratory, Pasadena, Calif., Jan. 7, 1957.
- Gilchriest, C. E., "Application of the Phase-Locked Loop to Telemetry as a Discriminator or Tracking Filter," *Trans. IRE*, Vol. TRC-4, pp. 20-35, June 1958.
- Golay, M. J. E., "The Application of Radio Interferometry to Extraterrestrial Metrology," *Trans. IRE*, Vol. SET-5, pp. 186-193, Dec. 1959.
- Hartl, P., "The Phase Locked Loop Principle and Its Application to Communication Receivers for Space Flight," *Raumfahrtforschung*, Vol. 8, pp. 55-64, Apr.-June 1964.
- Henderson, R. E., "Measuring the Doppler Frequency Shift on Satellite Transmissions," *Brit. Commun. Electron.*, Vol. 8, No. 7, pp. 506-512, 1961.
- Huylar, J., Lawhorn, R., and Weaver, C. S., *Study of Adaptive Processes Applied to Phase-Locked Loops*, Tech. Doc. Rep., AD-609 242, Philco Corp., Palo Alto, Calif., Dec. 1961.

- Jankovich, J. L., "Phase-Locked Interferometer," *Proc. 16th Int. Astronaut. Congr.*, Athens, Greece, p. 33, Sept. 1965.
- Jennings, R. R., and Miller, D. C., *A Low Noise Correlation Frequency Tracker*, AD-412 630, Naval Avionics Facility, Indianapolis, Ind., Feb. 1962.
- Kline, A. J., and Moore, W. C., "Phase-Lock Loops in Space Communications," *Instrum. Contr. Syst.*, Vol. 39, pp. 131-135, Sept. 1966.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Chap. 3, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.
- Lindsey, W. C. and Simon, M. K., *Telecommunication Systems Engineering*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1973.
- Martin, B. D., *The Pioneer IV Lunar Probe: A Minimum-Power FM/PM System Design*, Technical Report 32-215, Jet Propulsion Laboratory, Pasadena, Calif., Mar. 15, 1962.
- Martin, T. B., "Circuit Applications of the Field-Effect Transistor," *Semicon. Prod.*, Vol. 5, Part I, pp. 33-39, Feb. 1962; Part II, pp. 30-38, Mar. 1962.
- Meer, S. A., "A Class of Wiener Filters Useful in PLL Applications," *Proc. IEEE*, Vol. 53, p. 2121, Dec. 1965.
- Moschytz, G. S., "Miniaturized RC Filters Using Phase-Locked Loop," *Bell Syst. Tech. J.*, Vol. 44, pp. 823-870, 1965.
- Murphy, J. V., "Frequency Measurement Using the Phase-Controlled Oscillator," *Proc. IEEE*, Vol. 55, No. 7, pp. 1144-1153, 1967.
- Osatake, T., and Fujii, A., "A Study on FM Reception by Tracking Filters," *Electron. Commun. Jap.*, Vol. 50, No. 6, pp. 100-108, 1967.
- Pierce, J. A., "Intercontinental Frequency Comparison by VLF Radio Transmission," *Proc. IRE*, Vol. 45, pp. 794-803, June 1957.
- Rajasekaran, P. K., and Srinath, M. D., "Switchless Control Strategies for Minimum Time Frequency Transitions in Phase-Locked Loops," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-5, pp. 984-988, 1969.
- Richman, D., "Color-Carrier Reference Phase Synchronization Accuracy in NTSC Color Television," *Proc. IRE*, Vol. 43, pp. 106-133, Jan. 1954.
- Richter, H., Stevens, R., and Sampson, W. F., *Microlock: A Minimum Weight Instrumentation System for a Satellite*, JPL External Publication No. 376, Jet Propulsion Laboratory, Pasadena, Calif.
- Shakhgildian, V. V., and Liakhovkin, A. A., "Filtering of a Monochromatic Signal by a Phase-Locked Oscillator," *Elektrosviaz*, Vol. 18, pp. 11-18, 1964.
- Smith, L. J., *Use of Phase-Lock Loop Control for Driving Ultrasonic Transducers*, N66-33455, NASA Lewis Research Center, Cleveland, Ohio, Aug. 1966.
- Springett, J. C., "Telemetry and Command Techniques for Planetary Spacecraft," in *Advances in Communication Systems Theory and Applications*, Vol. I, pp. 77-128, edited by A. V. Balakrishnan, Academic Press, Inc., New York, 1965.
- Stein, J. J., and Weber, C. L., "Cascaded Phase Locked Loops," *Proc. NEC 68*, National Electronics Conference, Chicago, Ill., pp. 181-186, 1968.

- Stiffler, J. J., "On the Selection of Signals for Phase-Locked Loops," Digest of papers, *Int. Conf. Commun.*, Minneapolis, Minn., June 1967.
- Strauch, R. G., "Phase Locking Millimeter Sources for Frequency Control," *Frequency*, Prototype Issue, pp. 16-18, 1962.
- Svoboda, D. E., *Phase and Amplitude Control for Arrays with Increased Directivity*, AD-461 633, Ohio State University Research Foundation, Columbus, Ohio, Mar. 1965.
- Svoboda, D. E., *A Phase-Locked Receiving Array for High-Frequency Communications Use*, AD-464 374, Antenna Lab., Ohio State University Research Foundation, Columbus, Ohio, Aug. 1963.
- Svoboda, D. E., "A Phase-Locked Receiving Array for High-Frequency Communications Use," *IEEE Trans. Anten. Prop.*, Vol. AP-12, pp. 207-215, 1964.
- Terent, C. V. P., and Shakhgildian, V. V., "Obtaining Highly Stable Variable Frequency by the Use of Automatic Phase Adjustment," *Telecommun. USSR (London)*, pp. 1194-1202, 1960.
- Thirup, G., "The Application of Phase-Locking Techniques to the Design of Apparatus for Measuring Complex Transfer Functions," *Brit. IRE*, pp. 387-396, May 1960.
- Wilson, C. S., and Warren, W. B., *A Frequency Measuring Spectrum Analyzer*, N66-15724, Eng. Experiment Station, Georgia Institute of Technology, Atlanta, Ga., Nov. 1965.
- Woodman, R. F., *A Phase-Locked Phase Filter for the Minitrack System*, NASA Technical Note D-1419, Goddard Space Flight Center, Sept. 1962.
- Woodyard, J. R., "Application of the Autosynchronized Oscillator to Frequency Demodulation," *Proc. IRE*, Vol. 25, pp. 612-619, 1957.
- Yen, C. S., "Phase-Locked Sampling Instruments," *IEEE Trans. Instrum. Meas.*, Vol. IM-14, pp. 64-68, 1965.
- Zaima, Y., *A Phase Lock System for Signal Modulated by a PN Sequence*, Naval Postgraduate School, Monterey, Calif., May 1966.

Q. Digital Phase-Locked Loops

- Abend, K., et al., *Advanced Digital Receiver Techniques*, Technical Report TR-68-169, AD 841 083, Rome Air Development Center, Griffiss Air Force Base, N. Y., Sept. 1968.
- Anderson, T. O., and Hurd, W. J., "Digital Transition Tracking Symbol Synchronizer for Low SNR Coded Systems," *IEEE Trans. Commun. Technol.*, Vol. COM-18, No. 2, pp. 141-146, Apr. 1970.
- Anderson, T. O., and Lindsey, W. C., "Digital-Data Transition Tracking Loops," *Proc. International Telemetry Conference*, Los Angeles, Calif., pp. 259-271, Oct. 8-11, 1968.
- Bhatt, U. N., *Elements of Applied Stochastic Processes*, John Wiley & Sons, Inc., New York, 1972.

- Byrne, C. J., "Properties and Design of the Phase-Controlled Oscillator with a Sawtooth Comparator," *Bell Syst. Tech. J.*, Vol. 41, pp. 559-602, Mar. 1962.
- Casson, W. H., *Advanced Digital FM-PM Demodulator ADD-15*, Report AD 648 813, Defense Electronics, Inc., Rockville, Md., Sept. 1966.
- Cessan, J. R., and Leavy, M. D., "Phase Noise and Transient Times for a Binary Quantized Digital Phase Locked Loop in White Gaussian Noise," *IEEE Trans. Commun.*, Apr. 1972.
- Cessna, J. R., "Steady State and Transient Analysis of a Digital Bit Synchronization Phase-Locked Loop," *Proc. IEEE International Conference on Communications*, San Francisco, Calif., Vol. 2, pp. 34-15 to 34-19, June 8-10, 1970.
- Drogen, E. M., "Steering a Course to Safer Air Travel," *Electronics*, pp. 95-102, Nov. 1967.
- Eisenberg, B. R., "Gated Phase-Locked Loop Study," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-7, pp. 469-477, May 1971.
- Feller, W., *An Introduction to Probability Theory and Its Applications*, Vol. I, John Wiley & Sons, Inc., New York, 1957.
- Fritchman, B., *Digital Equivalent Transreceiver Study*, Technical Report TR-68-539 AD 851 364, Rome Air Development Center, Griffiss Air Force Base, N. Y., Mar. 1969.
- Garodnick, J., Greco, J., and Schilling, D. L., "An All Digital Phase Locked Loop for FM Demodulation," *Proc. IEEE International Conference on Communications*, June 1972.
- Garodnick, J., Greco, J., and Schilling, D. L., "Design of an All Digital FM Discriminator," *Conv. Rec. FEC*, pp. 398-399, Fall 1971.
- Gill, G. S., and Gupta, S. C., "First Order Discrete Phase Locked Loop with Applications to Demodulation of Angle-Modulated Carrier," *IEEE Trans. Commun.*, June 1972.
- Gill, G. S., and Gupta, S. C., "On Higher Order Discrete Phase Locked Loop," *IEEE Trans. Aerosp. Electron. Syst.*, Sept. 1972.
- Goto, H., "A Digital Phase-Locked Loop for Synchronizing Digital Networks," *Conf. Rec. IEEE International Conference on Communications*, San Francisco, Calif., 70-CP-362-COM, p. 34-20, 1970.
- Gupta, S. C., "On Optimum Digital Phase-Locked Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 340-344, Apr. 1968.
- Gupta, S. C., "Status of Digital Phase Locked Loops," *Proc. Hawaii Conference*, Jan. 1970.
- Holmes, J. K., "Performance of a First Order Transition Sampling Digital Phase Locked Loop Using Random Walk Models," *IEEE Trans. Commun.*, Apr. 1972.
- Holmes, J. K., "Random Walk Techniques in the Solution of First Order Digital Phase-Locked Loops," *Proc. Fourth Hawaii International Conference on System Sciences*, University of Hawaii, Honolulu, pp. 664-666, Jan. 12-14, 1971.
- Holmes, J. K., "On a Solution to a Digital First Order Phase Lock Loop," *Mervin J. Kelly Commun. Conf.*, University of Missouri-Rolla, Oct. 1970.

- Jazwinski, A. H., *Stochastic Processes and Filtering Theory*, Academic Press, Inc., New York, 1970.
- Judd, L. F., *Sample Data Analysis of Digital Phased-Locked Loops*, M.S. thesis, Texas Technological University, Lubbock, 1967.
- Kelly, C. N., *Discrete Time Demodulation of Continuous Time Signals*, Ph.D. dissertation, Southern Methodist University, Dallas, Tex., May 1971.
- Kelly, C. N., and Gupta, S. C., "The Digital Phase-Locked Loop as a Near Optimum FM Demodulator," *IEEE Trans. Commun. Technol.*, Vol. COM-20, No. 3, June 1972.
- Larimore, W. E., *Design and Performance of a Second-Order Digital Phase-Locked Loop*, Polytechnic Institute of Brooklyn, New York, Apr. 1969.
- Larimore, W. E., "Synthesis of Digital Phase-Locked Loops," Records of *EASCON '68*, Washington, D. C., pp. 14-20, Sept. 9-11, 1968.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Chap. 3, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.
- Natali, F. D., "Accurate Digital Detection of Angle-Modulated Signals," Records of *EASCON '68*, Washington, D. C., pp. 407, 413, Sept. 9-11, 1968; also "Digital Processing Receiver Study," AD 835-767.
- Pasternak, G., and Whalin, R. L., "Analysis and Synthesis of a Digital Phase-Locked Loop for FM Demodulation," *Bell Syst. Tech. J.*, Vol. 47, No. 10, pp. 2207-2239, Dec. 1968.
- Sanders, R. W., "Digilock Telemetry System," presented at *Nat. Symp. Space Electron. Telemetry*, San Francisco, Calif., Sept. 1959.
- Sanger, D. K., *Digital Demodulation with Data Subcarrier Tracking*, Technical Report 32-1314, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 1, 1968.
- Schilling, D., et al., "Digital Phase-Locked Loop FM Demodulator," presented at the *IEEE Int. Conf. Communications*, Montreal, Que., Canada, 1971.
- Schwartz, M., Bennett, R. W., and Stein, S., *Communication Systems and Techniques*, McGraw-Hill Book Co., Inc., New York, 1966.
- Sepe, R. B., "Utilizing a Digital Control Loop," *Comput. Des.*, pp. 54-63, May 1968.
- Tausworthe, R. C., "Digital Communication and Tracking: Limit-Cycles in Passive-Filter Phase-Locked Loops," in *Supporting Research and Advanced Development*, Space Programs Summary 37-41, Vol. IV, pp. 268-270, Jet Propulsion Laboratory, Pasadena, Calif., Oct. 31, 1966.
- Vanblerkom, R., et al., *Advanced Digital Receiver Design Study*, Technical Report TR-66-602, AD 805 009, Rome Air Development Center, Griffiss Air Force Base, N. Y., Nov. 1966.
- Webb, J. A., "Optimum Demodulation Using Digital Sampled Data," *SWIEEECO Rec.*, pp. 209-213, Apr. 1970.
- Westlake, P. R., "Digital Phase Control Techniques," *IRE Trans. Commun. Syst.*, Vol. CS-8, pp. 237-246, Dec. 1960.

R. Miscellaneous

- Active Notch Filter*, AD-438 252, Eng. Experiment Station, Georgia Institute of Technology, Atlanta, Ga., Apr. 1964.
- Altman, F. J., "Power Control for Comsat Multiple Access," Records of *Int. Space Electron. Symp.*, Las Vegas, Nev., pp. 6-E-1 to 6-E-5, Oct. 1964.
- Bambini, A., and Burlamacchi, P., "Phase Locking of a Multimode Gas Laser by Means of Low-Frequency Cavity-Length Modulation," *J. Appl. Phys.*, Vol. 39, pp. 4864-4865, 1968.
- Barnes, J. A., and Mockler, R. C., "The Power Spectrum and Its Importance in Precise Frequency Measurements," *Trans. IRE*, Vol. I-9, pp. 149-155, Sept. 1960.
- Barry, J. G., Dalrymple, G. F., Fielding, J. C., Goldstein, B. S., and Higgins, W. F., "A Proposed Spacecraft to Earth Communications Link—The Unified Carrier Approach," *IEEE Trans. Commun. Electron.*, Vol. CE-83, pp. 593-603, 1964.
- Bickmore, R. W., "Adaptive Antenna Arrays," *Spectrum*, Vol. 1, pp. 78-88, Aug. 1964.
- Biswas, B. N., "Compound Feedback Phase Locked Loops," Lecture delivered at the Czechoslovak Academy of Sciences, Prague, Aug. 1970.
- Biswas, B. N., "Frequency Feedback Phase Locked Oscillator," *Int. J. Electron.*, Vol. 25, pp. 565-583, June 1968.
- Biswas, B. N., "Linearization of Phase Locked Loops by the Gegenbauer Polynomials," *Int. J. Electron.*, Vol. 24, pp. 279-282, Mar. 1968.
- Biswas, B. N., "On the Output Spectra of Unlocked Driven Oscillator," *Proc. IEEE (Letters)*, May 1970.
- Biswas, B. N., "The Phenomenon of Pulsed Subharmonic Oscillation," *J. Inst. Telecommun. Eng.*, Vol. 14, pp. 409-411, Sept. 1968.
- Biswas, B. N., "Simultaneous Oscillations at Three Frequencies in a Regenerative Circuit with a Limiter Type Non-Linear Element," *Indian J. Phys.*, Vol. 38, pp. 561-582, Nov. 1964.
- Blake, I. F., and Lindsey, W. C., "Communications Systems Development: Effects of Phase-Locked Loop Dynamics on Phase-Coherent Communications," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 192-195, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.
- Breese, M., et al., "Phase Locked Loops for Electronically Scanned Antenna Arrays," *Globecom V Conv. Rec.*, pp. 85-89, 1961.
- Camfield, G. J., "A Frequency Generating System for UHF Communication Equipment," *Proc. IEE (Brit.)*, Vol. 101, Part 3, pp. 85-90, 1954.
- Carl, C., "Approximate Analysis of Channel Imbalance Effects in Non-Coherent FSK Receivers With Large BT Products," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 211-220, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.
- Carnt, P. S., and Ribchester, E., "The Synthesis of High Purity Oscillations Suitable for Single Sideband Receivers," *J. Brit. Inst. Radio Eng.*, Vol. 21, No. 3, pp. 237-240, 1961.

- Chance, B., et al., *Waveforms*, MIT Rad. Lab. Series, Vol. 19, pp. 511-524, McGraw-Hill Book Co., Inc., New York, 1949.
- Chang, S. S. L., and Harris, B., "An Optimum Self-Synchronized Communication System," *Trans. Amer. Inst. Elec. Eng., Part I*, Vol. 81, pp. 110-116, 1962.
- Clarke, K. K., Pickholtz, R. L., and Schilling, D. L., *A Space Communications Study Progress Report*, Polytechnic Institute of Brooklyn, New York, Sept. 15, 1967-Mar. 15, 1968.
- Costas, J. P., "Some Notes on Space Communications," *Proc. IRE*, Vol. 47, pp. 1383-1385, 1959.
- Costas, J. P., "Synchronous Communications," *Proc. IRE*, Vol. 44, pp. 1713-1718, Dec. 1956.
- Develet, J. A., "Coherent FDM/FM Telephone Communication," *Proc. IRE*, Vol. 50, No. 9, pp. 1957-1966, 1962.
- Develet, J. A., *Coherent FDM/FM Telephone Communication*, Technical Report No. 8614-6004-NU-000, Space Technol. Lab., Los Angeles, Calif., Jan. 1, 1962.
- Dollard, P. M., and Jacobs, I., *Weak-Signal Communication Techniques (U)*, AD-299 219, Bell Telephone Lab., Inc., Whippany, N. J., Apr. 1962.
- Easterling, M., *A Long-Range Precision Ranging System*, Technical Report 32-80, Jet Propulsion Laboratory, Pasadena, Calif., July 10, 1961.
- Felch, E. P., and Israel, J. O., "A Simple Circuit for Frequency Standards Employing Overtone Crystals," *Proc. IRE*, Vol. 43, pp. 596-603, May 1955.
- Finden, H. J., "The Problem of Frequency Synthesis," *J. Brit. Inst. Radio Eng.*, Vol. 21, No. 1, pp. 95-103, 1961.
- Gardner, F. M., *Phaselock Techniques*, John Wiley & Sons, Inc., New York, 1966.
- Glenn, A. B., "Mars Voyager-Lander Direct Link Communications System," *RCA Eng.*, Vol. 12, pp. 70-74, 1967.
- Goldstein, A. J., and Byrne, C. J., "The Phase-Controlled Loop with a Sawtooth Comparator," Convention Records of the *Northeast Electron. Res. Eng. Meeting*, Boston, Mass., Nov. 1960.
- Guers, K., "Modulation and Mode Locking of the Continuous Ruby Laser," *IEEE J. Quantum Electron.*, Vol. 3, pp. 175-180, 1967.
- Hetzheim, H., "The Method of Chronological Ordering of Operators for the Calculation of Nonlinear Unsteady Systems," *Hochfrequenztechnik Und Elektroakustik*, Vol. 80, pp. 55-73, Apr. 1971 (in German).
- Hill, E. R., *Techniques for Synchronizing Pulse-Code-Modulated Telemetry (U)*, AD-402 192, Naval Ordnance Laboratory, Corona, Calif., Feb. 1963.
- Holmes, J. K., "Coding and Synchronization Studies: On Solution to the Second-Order Phase-Locked Loops," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 182-186, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.
- Holzmann, E. G., "Pulsed Phase-Locked Loops," *Proc. 4th Joint Automatic Control Conference*, University of Minnesota, Minneapolis, Minn., pp. 398-403, June 19-21, 1963.

- Jensen, G. K., *An Active Filter*, Report No. 4630, Naval Research Laboratory, Washington, D. C., Nov. 10, 1955.
- Kapranov, M. V., *Radiotekhnika*, Vol. 11, No. 12, pp. 37-52, Dec. 1956.
- Kendall, W. B., Levy, G. S., Nixon, D. L., and Panson, P. L., "Data Processing Method for a Weak, Moving Telemetry Signal," *IEEE Trans. Instrum. Meas.*, Dec. 1968. Also NASA Tech Brief 69-10639, National Aeronautics and Space Administration, Washington, D. C., 1969.
- Klapper, J., and Rabinovici, B., *A Frequency Synthesizer Study for the Proposed AN/GRC-103* RCA Report CR-62-419-8, AD 289 562, RCA Corp., July 1962.
- Laughlin, C. R., "The Diversity-Locked Loop—A Coherent Combiner," *IEEE Trans. Space Electron. Telem.*, Vol. SET-9, pp. 84-91, Sept. 1963.
- Lindsey, W. C., "Coding and Synchronization Studies: Dynamics of Second-Order Phase-Locked Loops," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 177-181, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.
- Lindsey, W. C., "Phase Density Distribution of Phase-Locked Loops in Cascade," *IEEE Trans. Commun. Technol.*, Vol. COM-17, No. 4, p. 503, 1969.
- Lindsey, W. C., and Hayes, J. F., "Coding and Synchronization Studies: Power Allocation Length Into Rapidly Varying Phase Error," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 187-190, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.
- Martin, B. D., *A Coherent Minimum-Power Lunar Probe Telemetry System*, JPL External Publication No. 610, Jet Propulsion Laboratory, Pasadena, Calif., May 1959.
- Martin, B. D., *The Mariner Planetary Communication System Design*, Technical Report 32-85, Rev. 1, Jet Propulsion Laboratory, Pasadena, Calif., May 15, 1961.
- McIntyre, R., *Transportable Satellite Communications Terminal X-Band Receiving Facility*, Final Technical Report, AD-618 907, Sylvania Electron. Syst., Williamsville, N. Y., June 1965.
- McLaughlin, R. J., *A Lock-On Probability Analysis for the Initial Synchronization of Phase-Locked Loops (U)*, Technical Report No. 372, AD-433 698, Cruft Lab., Harvard University, Cambridge, Mass., Feb. 1963.
- Merrick, W., Rechtin, E., Stevens, R., and Victor, W., "Deep Space Communications," *IRE Trans.*, Vol. MIL-4, No. 2-3, pp. 158-162, 1960.
- Methods and Techniques Study Report, Three-Oscillator Combiner*, AD-617 144, ITT Federal Labs., Nutley, N. J., June 1965.
- Osatake, T., Fujii, A., and Akutagawa, T., "A Study on a Parametric Amplifier as a Tracking Filter," *Electron. Commun. Jap.*, Vol. 51B, No. 6, pp. 63-69, 1968.
- Rechtin, E., *The Design of Optimum Linear Systems*, JPL External Publication No. 204, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 1953.
- Rihaczek, A. W., *Dynamic Bandwidth of Phase-Modulated Signals*, Aerospace Corp., El Segundo, Calif., Aug.-Oct. 1967.
- Rowbotham, J. R., *Phase-Locked Loop Study*, N68-80467, Final Report, Motorola, Inc., Scottsdale, Ariz., June 15, 1961.

- Sampson W. F., and Ruegg, F. A., "Phase-Lock in Space Communications," Paper 1-3, *Proc. Nat. Symp. Space Electron. and Telem.*, Sept. 1959.
- Schilling, D. L., *Optimal Space Communications Techniques*, Status Report, City College of New York, New York, Mar. 16-June 15, 1970.
- Schilling, D. L., *Optimal Space Communications Techniques*, Status Report, City College of New York, New York, Sept. 15-Dec. 15, 1970.
- Schuchman, L., *Characterizing the Behavior of Phase Lock Loops*, N70-26998, Bellcomm, Inc., Washington, D. C., Feb. 20, 1970.
- Study Report for the Development of Techniques to Automatically Acquire the Carrier of AM or PM Signals*, N67-35322, Electrac, Inc., Anaheim, Calif., June 15, 1967.
- Tausworthe, R. C., "Communications Systems Development: Efficiency of Noisy Reference Detection," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 195-201, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.
- Tausworthe, R. C., "Information Processing: Limiters in Phase-Locked Loops: A Correction to Previous Theory," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 201-204, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.
- Uyeda, H., "Accuracy of Frequency Comparison," *J. Radio Res. Lab.*, Vol. 10, pp. 335-345, 1963.
- Van de Pol, B., "On Oscillation Hysteresis in a Triode Generator with Two Degrees of Freedom," *Philosophical Magazine*, Vol. 43, pp. 700-719, Jan.-June 1922.
- Van Trees, H. L., *Optimum Power Division in Coherent Communication Systems*, AD-406 882, Lincoln Lab., M.I.T., Lexington, Mass., Feb. 1963.
- Warren, W. B., "Tracking Notch Filter for the Rejection of CW Interference," *Proc. 9th Tri-Service Conf. Electromagn. Compatibility*, Chicago, Ill., pp. 326-339, Oct. 1963.
- Weaver, C. S., *Preliminary Studies of Adaptive Processes Applied to Phase Locked Loops*, WDL-TR-1334, Philco Corp., Sept. 15, 1960.
- Williams, T. R., *A Note on Phase-Locked Loops in Space Communications*, N67-22749, pp. 111-119, Goddard Summer Workshop, 1966.
- Yang, K. H., "A Study of Capture Bandwidth of Phase Locked Loops with a Non-linear Integrating Filter," *Electron. Mainland China*, Part II, pp. 29-42, 1969.

III. Alphabetic Listing by Authors

- Abend, K., et al., *Advanced Digital Receiver Techniques*, Technical Report TR-68-169, AD 841 083, Rome Air Development Center, Griffiss Air Force Base, N. Y., Sept. 1968.
- Abrams, B. S., Oberst, J. F., Berkoff, M., and Schilling, D. L., *Phase Locked Loop Threshold Investigations*, Report PIBMRI-1274-65, Polytechnic Institute of Brooklyn, New York, June 1965.
- Acampora, A., *Advanced FM Demodulator*, RCA Quarterly Report, Jan. 1-Mar. 31, 1967.
- Acampora, A., and Newton, A., "Use of Phase Subtraction to Extend the Range of a Phase-Locked Demodulator," *RCA Rev.*, Vol. 27, pp. 577-599, Dec. 1966.
- Acampora, A., and Newton, A., "The Use of Phase Subtraction for Increasing the Range of a Phase-Locked Loop," *Proc. National Electronics Conference*, Chicago, Ill., Vol. 23, Oct. 23-25, 1967.
- Acampora, A., and Tepfer, A., *Advanced FM Demodulator*, RCA Quarterly Progress Report, Oct. 1-Dec. 31, 1966.
- "Acquisition and Tracking System for Space Vehicles," *Space Commun. Technol.*, Vol. I, pp. 84-86, Philco Research Division, Nov. 29, 1960.
- Active Notch Filter*, AD-438 252, Eng. Experiment Station, Georgia Institute of Technology, Atlanta, Ga., Apr. 1964.
- Adler, R., "A Study of Locking Phenomena in Oscillators," *Proc. IRE*, Vol. 34, pp. 351-357, 1946.
- Advanced Threshold Reduction Techniques Study*, First Quarterly Report, ADCOM, Inc., Cambridge, Mass., July 1-Sept. 30, 1964.
- Aein, J. M., *Coherency Criterion for the Binary Symmetric Channel*, N69-31221, Institute for Defense Analysis, Arlington, Va., Mar. 1969.
- Aetjen, R. M., *Cancellation of Doppler Frequency Shift (U)*, AD-404 428, Air Force Cambridge Research Laboratories, Bedford, Mass., Mar. 1963.
- Alexander, P. H., and Kalra, S. N., "Unlock Characteristics of a Phase-Locked Loop," *Proc. IEEE (Letters)*, p. 1138, 1965.
- Altman, F. J., "Power Control for Comsat Multiple Access," Records of *Int. Space Electron. Symp.*, Las Vegas, Nev., pp. 6-E-1 to 6-E-5, Oct. 1964.
- Anderson, D. R., and Luh, Y. Y. S., "An Analysis of High Order Phase-Locked Loop Behavior in the Presence of White Noise," Digest of Technical Papers, *Int. Commun. Conf.*, Minneapolis, Minn., p. 139, June 1967.
- Anderson, T. C., and Merrill, F. G., "Crystal-Controlled Primary Frequency Standards: Latest Advances for Long-Term Stability," *Trans. IRE*, Vol. I-9, pp. 136-140, Sept. 1960.
- Anderson, T. O., and Gallo, A. J., "Design for a Rapid Automatic Sync Acquisition System," *Instrument Society of America 13th National Aerospace Symposium*, San Diego, Calif., June 13-16, 1967.

- Anderson, T. O., and Hurd, W. J., "Digital Transition Tracking Symbol Synchronizer for Low SNR Coded Systems," Conference Records of *International Conference on Communications*, Boulder, Colo., pp. 20-1 to 20-8, June 9-11, 1969.
- Anderson, T. O., and Hurd, W. J., "Digital Transition Tracking Symbol Synchronizer for Low SNR Coded Systems," *IEEE Trans. Commun. Technol.*, Vol. COM-18, No. 2, pp. 141-146, Apr. 1970.
- Anderson, T. O., and Lindsey, W. C., "Digital-Data Transition Tracking Loops," *Proc. International Telemetry Conference*, Los Angeles, Calif., pp. 259-271, Oct. 8-11, 1968.
- Antsibor, N. M., and Kurbatov, A. V., "Tuning Out False Lockings in Phase Regulated AFC Systems with Pulsed Phase Detectors," *Elektrosvyaz*, Vol. 24, pp. 44-51, Nov. 1970 (in Russian).
- Arndt, G. D., and Loch, F. J., "A Comparative Analysis of Frequency Modulation Threshold Extension Techniques," *Proc. International Conference on Communications*, San Francisco, Calif., Vol. 1, pp. 21-20 to 21-26, June 8-10, 1970.
- Arnold, J., and Leclercq, M., "Measurements of Phase and Amplitude with the Aid of Phase-Locked Filters," *l'Echo Rech.*, pp. 70-75, Apr. 1966.
- Arronson, G., Acampora, A., Frankle, J. T., Klapper, J., and McLaughlin, P. J., "Error Rates with Angular Feedback Demodulators," Records of NTC 68, *National Telemetry Conference*, Houston, Tex., Apr. 8-11, 1968.
- Artym, A. D., "The Applications of a Phase Automatic Frequency Controller," *Radio Eng. USSR*, Vol. 13, No. 8, pp. 48-59, 1958.
- Attkinson, W. R., Fey, L., and Newman, J., "Spectrum Analysis of Extremely Low Frequency Variations of Quartz Oscillators," *Proc. IRE*, Vol. 51, p. 379, Feb. 1963.
- Attwood, S., and Kline, A. J., *Phase-Locked Loop Frequency Control and the Dropout Problem*, NASA Tech Brief 68-10130, National Aeronautics and Space Administration, Washington, D. C., Apr. 1968.
- Aupperle, E. M., *Locked Instability and Forced Oscillations in Automatic Phase Control Systems*, Technical Report AD-463100, Cooley Electronics Laboratory, University of Michigan, Ann Arbor, Mich., Dec. 1964.
- "Automatic Acquisition for Narrow Bandwidth, Phase-Locked, Reference Loops," in *The Deep Space Instrumentation Facility*, Space Programs Summary 37-21, Vol. III, pp. 61-62, Jet Propulsion Laboratory, Pasadena, Calif., May 31, 1963.
- Baghdady, E. J., "Theoretical Comparison of Exponent Demodulation by Phase-Locked and Frequency-Compressive Feedback Techniques," *IEEE International Convention Record*, Vol. 12, pp. 402-421, 1964.
- Baghdady, E. J., and Marshall, A. C., *FM Improvement Techniques*, Final Report, N63-22119, ADCOM, Inc., Cambridge, Mass., Feb. 1, 1963.

- Baird, C. A., Jr., *A Dual-Mode Phase-Locked Loop*, Harry Diamond Laboratories, Washington, D. C., Sept. 30, 1965.
- Baird, C. A., Jr., "Modified Quasilinearization Technique for the Solution of Boundary-Value Problems for Ordinary Differential Equations," *J. Optimization Theory Appl.*, Vol. 3, No. 4, pp. 227-242, 1969.
- Bakaev, Yu. N., "Study of Television Flywheel Synchronization System," *Radio Eng. Electron.*, Vol. 3, pp. 315-329, 1958.
- Bakaev, Yu. N., "Synchronization Properties of a Phase Type AGC of the Third-Order," *Radiotekhnika I Elektronika*, Vol. 10, pp. 926-929, June 1965 (translation).
- Bakaev, Yu. N., "Synchronizing Properties of a Third-Order Phase-Locked Oscillator System," *Radiotekhnika I Elektronika*, Vol. 10, pp. 1083-1087, June 1965 (in Russian).
- Baker, T. S., *Analysis of the Synchronization of an Automatic Phase Control System*, AD-610 691, Cruft Laboratory, Harvard University, Cambridge, Mass., Nov. 1964.
- Baker, T. S., "Synchronization of Phase-Locked Loops," *NEREM Rec.*, Boston, Mass., pp. 44-45, Nov. 1964.
- Balodis, M., "Laboratory Comparison of Tanlock and Phaselock Receivers," *Proc. National Telemetry Conference*, Los Angeles, Calif., June 2-4, 1964.
- Bambini, A., and Burlamacchi, P., "Phase Locking of a Multimode Gas Laser by Means of Low-Frequency Cavity-Length Modulation," *J. Appl. Phys.*, Vol. 39, pp. 4864-4865, 1968.
- Banta, E. D., *Lock-In in APC Systems*, Report No. 38, Philco Mathematics Group, 1954.
- Barnard, R. D., "Variational Techniques Applied to Capture in Phase-Controlled Oscillators," *Bell Syst. Tech. J.*, Vol. 41, pp. 227-256, Jan. 1962.
- Barnes, J. A., and Mockler, R. C., "The Power Spectrum and Its Importance in Precise Frequency Measurements," *Trans. IRE*, Vol. I-9, pp. 149-155, Sept. 1960.
- Barry, J. G., Dalrymple, G. F., Fielding, J. C., Goldstein, B. S., and Higgins, W. F., "A Proposed Spacecraft to Earth Communications Link—The Unified Carrier Approach," *IEEE Trans. Commun. Electron.*, Vol. CE-83, pp. 593-603, 1964.
- Bautin, N. N., "Qualitative Study of a Certain Equation of the Theory of Phase Automatic Frequency Control," *Prikladnaia Matematika I Mekhanika*, Vol. 34, pp. 850-860, Sept.-Oct. 1970 (translation).
- Bayless, J. W., and Gupta, S. C., "Status of FM Feedback in Communication Systems," *IEEE Trans. Aerosp. Electron. Syst.*, Supplement, Vol. AES-3, pp. 11-23, 1967.
- Bayless, J. W., and Gupta, S. C., "Threshold Extension Using Phase Lock Demodulator in a FM Feedback Loop," Records of NTC 68, *National Telemetry Conference*, Houston, Tex., Apr. 8-11, 1968.
- Bayless, J. W., Gupta, S. C., and Hummels, D. R., "Threshold Investigation of Phase-Locked Discriminators," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-4, pp. 855-863, 1968.

- Becker, H. D., Chang, T. T., and Lawton, J. G., *Investigations of Advanced Analog Communications Techniques*, TR, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., Dec. 23, 1963–Dec. 23, 1964.
- Beers, G. L., "A Frequency-Dividing Locked-In Oscillator FM Receiver," *Proc. IRE*, Vol. 32, pp. 730–737, 1944.
- Beery, W. M., *Frequency Stabilization of Frequency-Shift-Keyed Transmission (U)*, AD-459 332, National Bureau of Standards, Boulder, Colo., Feb. 1965.
- Benes, J., *Statistical Dynamic of Automatic Control System*, ILIFF Books, Ltd., 1967.
- Benes, V. E., "Ultimately Periodic Solutions to a Nonlinear Integrodifferential Equation," *Bell Syst. Tech. J.*, Vol. XLI, pp. 257–268, Jan. 1962.
- Benjaminson, A., "Phase-Locked Klystrons Simulate Doppler Radar," *Electronics*, pp. 44–46, Apr. 19, 1963.
- Benjaminson, A., "Phase-Locking Microwave Oscillators to Improve Stability and Frequency Modulation," *Microwave J.*, pp. 88–92, Jan. 1963.
- Benjaminson, A., "Phase-Locked Microwave Oscillator Systems with 0.1 cps Stability," *Microwave J.*, pp. 65–69, Dec. 1964.
- Bershtein, I. L., "On the Theory of Automatic Phase Control of Frequency," *Radio Eng. Electron. USSR*, Vol. 3, No. 2, pp. 410–414, 1958.
- Bershtein, I. L., and Sibiryakov, V. L., "Automatic Phase Control of Microwave Oscillator Frequency," *Radio Eng. Electron. USSR*, Vol. 3, No. 2, pp. 415–418, 1958.
- Bershtein, I. L., and Sibiryakov, V. L., "Phase Stabilization of Microwave Oscillators," *Radio Eng. Electron. USSR*, Vol. 2, No. 7, pp. 184–185, 1957.
- Berube, R. H., and Lindgren, A. G., "Noise Dynamics of a Phase-Locked Loop with Nonlinear Signal Processing," *Proc. 21st National Aerospace Electronics Conference, Dayton, Ohio*, pp. 399–402, May 19–21, 1969.
- Berube, R. H., Lindgren, A. G., and Pinkos, R. F., "Noise Dynamics of the Phase-Locked Loop with Signal Clipping," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-5, pp. 66–76, 1969.
- Bespalvo, E. S., and Kuleshov, V. N., "Synthesis of a Filtration and Correction Circuit for a Phase-Locked Automatic Frequency Control System, Which Separates a Sinusoidally Frequency-Modulated Signal from Noise," *Radio-elektronika*, Vol. 11, pp. 324–331, Apr. 1968 (in Russian).
- Bhatt, U. N., *Elements of Applied Stochastic Processes*, John Wiley & Sons, Inc., New York, 1972.
- Bickmore, R. W., "Adaptive Antenna Arrays," *Spectrum*, Vol. 1, pp. 78–88, Aug. 1964.
- Billig, J., and Schilling, D. L., "A Comparison of the Threshold Performance of the Frequency Demodulator Using Feedback and the Phase Locked Loop," Record of the 1965 *International Symposium on Space Electronics*, Miami Beach, Fla., Nov. 2–4, 1965.

- Biswas, B. N., "Capture Capability of Automatic Phase Control Circuits in a Noisy Environment," *Proc. 14th (Midwest) IEEE Symposium on Circuit Theory*, Feb. 1970.
- Biswas, B. N., "Combination Injection Locking with Indirect Synchronization Technique," *IEEE Trans. Commun. Technol.*, Vol. COM-19, Aug. 1971.
- Biswas, B. N., "Compound AFC-APC FM Demodulators," *Proc. IEEE (Letters)*, Vol. 56, pp. 204-206, Feb. 1968.
- Biswas, B. N., "Compound Feedback Phase Locked Loops," Lecture delivered at the Czechoslovak Academy of Sciences, Prague, Aug. 1970.
- Biswas, B. N., "Frequency Feedback Phase Locked Oscillator," *Int. J. Electron.*, Vol. 25, pp. 565-583, June 1968.
- Biswas, B. N., "Harmonic Synchronization of Oscillators Revised," *IEEE Trans. Circuit Theory*, Nov. 1972.
- Biswas, B. N., "An Improvement in the Technique of Time Measurement," *Indian J. Phys.*, July 1967.
- Biswas, B. N., "On the Injection Synchronized Oscillator," *Proc. IEEE (Letters)*, Vol. 54, p. 880, June 1966.
- Biswas, B. N., "Interference Reduction in Second Order Injection Synchronized Oscillator," presented at the 60th Indian Science Congress, 1972.
- Biswas, B. N., "Interrupted Wave Synchronization," *Indian J. Phys.*, Vol. 41, pp. 209-225, Mar. 1967.
- Biswas, B. N., "Linearization of Phase Locked Loops by the Gegenbauer Polynomials," *Int. J. Electron.*, Vol. 24, pp. 279-282, Mar. 1968.
- Biswas, B. N., "Locking Phenomena in Injection Synchronized Pulsed Oscillator," *Indian J. Phys.*, Vol. 40, pp. 244-252, May 1966.
- Biswas, B. N., "Locking Phenomena in Phase Locked Oscillators," *Indian J. Phys.*, Vol. 38, pp. 148-175, Mar. 1964.
- Biswas, B. N., "On the Output Spectra of Unlocked Driven Oscillator," *Proc. IEEE (Letters)*, May 1970.
- Biswas, B. N., "On the Performance of Automatic Phase Control Circuit," presented at the *Symposium on Electronics and Telecommunications*, Calcutta University, Feb. 27-28, 1964.
- Biswas, B. N., "Phase Following Behavior of an APC Circuit with Respect to an FM Signal Contaminated with Stationary Random Noise," *Indian J. Phys.*, Vol. 41, pp. 648-668, Dec. 1966.
- Biswas, B. N., "Phase Jumping Phenomena in Frequency Dividers," *Int. J. Electron.*, Vol. 29, pp. 161-164, Feb. 1970.
- Biswas, B. N., "Phase Locked Loops in the Demodulation of AM and FM Signals," report in collaboration with Prof. J. H. Park for the University of Minnesota, 1970.
- Biswas, B. N., "Phase Locked Pulsed Oscillators," *Indian J. Pure Appl. Phys.*, Aug. 1967.

- Biswas, B. N., "Phase Locking Method of Measuring Dielectric Constant," *J. Sci. Instrum.*, Vol. 44, p. 557, July 1967.
- Biswas, B. N., "The Phenomenon of Pulsed Subharmonic Oscillation," *J. Inst. Telecommun. Eng.*, Vol. 14, pp. 409-411, Sept. 1968.
- Biswas, B. N., "Pseudo-Indirect Synchronization," *Indian J. Pure Appl. Phys.*, Jan. 1972.
- Biswas, B. N., "R.M.S. Frequency Error of Injection Synchronized Oscillator," *IEEE Trans. Circuit Theory*, Nov. 1970.
- Biswas, B. N., "Simultaneous Oscillations at Three Frequencies in a Regenerative Circuit with a Limiter Type Non-Linear Element," *Indian J. Phys.*, Vol. 38, pp. 561-582, Nov. 1964.
- Biswas, B. N., "A Tracking Loop for the Apollo Unified S-Band Communication System," presented at the 60th Indian Science Congress, 1972.
- Biswas, B. N., and Datta, G., "Tunable Compound Phase Locked Demodulators," *Proc. IEEE (Letters)*, Vol. 55, pp. 2044-2045, Oct. 1967.
- Blake, I. F., and Lindsey, W. C., "Communications Systems Development: Effects of Phase-Locked Loop Dynamics on Phase-Coherent Communications," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 192-195, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.
- Booton, R. C., Jr., "The Analysis of Nonlinear Control Systems with Random Inputs," *Proc. Symposium on Nonlinear Circuit Analysis*, Polytechnic Institute of Brooklyn, New York, pp. 369-391, Apr. 1953.
- Booton, R. C., Jr., "Demodulation of Wideband Frequency Modulation Utilizing Phase-Lock Technique," *Proc. National Telemetry Conference*, Vol. II, May 23-25, 1962.
- Boyer, R., *Digital Control of a Second-Order Linear AFC System with a Large Time Delay*, N65-24984, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 30, 1962.
- Bozzoni, E. A., Marchetti, G., Mengali, U., and Russo, F., "An Extension of Viterbi's Analysis of the Cycle Slipping in a First-Order Phase-Locked Loop," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-6, pp. 484-490, July 1970.
- Bozzoni, E., and Mengali, U., "Comparison Between the Oscillating Limiter and the First-Order Phase-Locked Loop," *Proc. IEEE*, Vol. 56, No. 11, p. 2094, Nov. 1968.
- Bratt, P., *Pull-in Performance of First-Order Phase-Locked Loops*, Mitre Corp., Bedford, Mass., Feb. 1965.
- Breese, M., Colbert, R., Rubin, W., and Sferrazza, P., "Phase-Locked Loops for Electronically Scanned Antenna Arrays," *Trans. IRE*, Vol. SET-7, pp. 95-100, Dec. 1961.
- Breese, M., et al., "Phase Locked Loops for Electronically Scanned Antenna Arrays," *Globecom V Conv. Rec.*, pp. 85-89, 1961.
- Breikss, I. P., "Digital FM Discriminator System," *Proc. International Telemetry Conference*, Los Angeles, Calif., pp. 257-278, Oct. 13-15, 1970.

- Britt, C. L., and Palmer, D. F., "Effects of CW Interference on Narrowband Second-Order Phase-Lock Loops," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-3, pp. 123-135, Jan. 1967.
- Brockman, M. H., Buchanan, H. R., Choate, R. L., and Malling, L. R., "Extraterrestrial Radio Tracking and Communication," *Proc. IRE*, Vol. 48, pp. 643-655, Apr. 1960.
- Brown, L. R., *Experimental Determination of Signal-to-Noise Relationships in PCM/FM and PCM/PM Transmission*, Interim Report NASA N62-13483, Electro-Mech. Res., Inc., Sarasota, Fla., Oct. 20, 1961.
- Bryan, J. W., *Carrier Reproduction in a Diversity Receiver*, N68-13879, NASA Goddard Space Flight Center, Greenbelt, Md., Oct. 1967.
- Bucy, R. S., Cheng, S. Y., and Mallinckrodt, A. J., *A Design Study for an Optimal Non-Linear Receiver/Demodulator*, N70-41881, Final Report, Electrac, Inc., Anaheim, Calif., Aug. 31, 1970.
- Burnett, E. E., "K_u-Band Phase-Locked System," *Proc. Nat. Winter Conv. Mil. Electron.*, 1963.
- Burnham, F., and Sandler, M., "The Lock-Lock Loop," Records of the *National Telemetry Conference*, Washington, D. C., pp. 228-232, Apr. 12-15, 1971.
- Burton, D. J., and Hebbert, R. S., *Third Order Phase Locked Loops*, Naval Ordnance Laboratory, White Oak, Md., Apr. 1969.
- Byelov, L. A., et al., "Simultaneous Automatic Phase Frequency Control and Synchronization," *Radio Eng. Electron. Phys. USSR*, Vol. 11, No. 2, pp. 1885-1890, Dec. 1966.
- Byrne, C. J., "Properties and Design of the Phase-Controlled Oscillator with a Sawtooth Comparator," *Bell Syst. Tech. J.*, Vol. 41, pp. 559-602, Mar. 1962.
- Cafissi, R., "Design of Threshold-Extension Phase-Lock Demodulators for Satellite Communications Stations," *Alta Frequenza*, Vol. 39, pp. 1081-1096, 1970 (in Italian).
- Cahn, C. R., "Piecewise Linear Analysis of Phase-Lock Loops," *Trans. IRE*, SET-8, pp. 8-13, Mar. 1962.
- Cahn, C. R., and Nilsen, P. W., "Loss of Lock and Reacquisition Performance of Carrier Tracking Loops," *Proc. 4th Hawaii International Conference on System Sciences*, Honolulu, pp. 667-669, Jan. 12-14, 1971.
- Cahn, R., and Viterbi, A. J., "Optimum Coherent Phase and Frequency Demodulation of a Class of Modulating Spectra," *IEEE Trans. Space Electron. Telem.*, Vol. SET-10, pp. 95-102, Sept. 1964.
- Caldwell, J. J., Rose, B. E., and Sydnor, R., "Frequency Stability Requirements for Space Communications and Tracking Systems," *Proc. IEEE*, Vol. 54, pp. 231-236, Feb. 1966.
- Cambi, E., "Some Remarks on the Phase-Lock Loop," *ITS Eldo Tech. Rev.*, Vol. I, No. 3, pp. 233-244, 1966.

- Cambi, E., *A Survey of the Phase-Lock Loop*, European Space Vehicle Launcher Development Organization, Paris, France, May 1966.
- Camfield, G. J., "A Frequency Generating System for UHF Communication Equipment," *Proc. IEE (Brit.)*, Vol. 101, Part 3, pp. 85-90, 1954.
- Camp, J. A., "A Comparison of the Threshold Extension Capabilities of FMFB and Phase-Lock Demodulators Employed in FDM-FM Communication Systems," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 191-200, 1969.
- Camp, J. A., *A General Method of Coherent Demodulation with Applications*, N69-21997, Arizona University, Tucson, Ariz., 1968.
- Cannon, L. E., Curtis, C. F., and Duncan, J. D., *FM Receiver Sensitivity Improvement Studies*, Quarterly Report, Montana State College, Bozeman, Mont., Feb. 15-Mar. 14, 1967.
- Carassa, F., and Rocca, F., "Advances in Phase-Lock Demodulation," *Int. Commun. Conf.*, Boulder, Colo., pp. 12.9-12.4, June 1969.
- Carden, F. F., Davis, G. L., Kelly, L. R., and Osborne, W. P., *A Study of the Immunity of FM Discriminators to 2π Frequency Impulses*, N69-13308, New Mexico State University, Las Cruces, N. M., 1968.
- Carden, F. F., Gilbert, A. L., and Osborne, W. P., "Phase Lock Loop Acquisition of an Angle Modulated Carrier," *Proc. National Aerospace Electronics Conference*, Dayton, Ohio, pp. 382-388, May 18-20, 1970.
- Carden, F. F., Hintz, T. B., and Kelly, L. R., "The FDM Demodulating Characteristics of Non-linear Phase-Locked Loops," *National Telemetry Conference*, Houston, Tex., Apr. 8-11, 1968.
- Carden, F. F., Merrill, M. D., Jones, T. J., and Martin, C. R., "The Non-Linear Transient Behavior of Second, Third and Fourth Order Phase-Locked Loops," Records of the *20th IEEE Annual Southwestern Conference and Exhibition*, Houston, Tex., Apr. 17-19, 1968.
- Carden, F., and Stewart, I. A., "Some Solutions and Stability Criteria for the Phase Lock Loop Equation," *Mervin J. Kelly Commun. Conf.*, University of Missouri-Rolla, Oct. 1970.
- Carl, C., "Approximate Analysis of Channel Imbalance Effects in Non-Coherent FSK Receivers With Large BT Products," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 211-220, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.
- Carnt, P. S., and Ribchester, E., "The Synthesis of High Purity Oscillations Suitable for Single Sideband Receivers," *J. Brit. Inst. Radio Eng.*, Vol. 21, No. 3, pp. 237-240, 1961.
- Casson, W. H., *Advanced Digital FM-PM Demodulator ADD-15*, Report AD 648 813, Defense Electronics, Inc., Rockville, Md., Sept. 1966.
- Casson, W. H., and Hall, C. C., "New Phase-Tracking Demodulator Will Not Lock on Sidebands," *Electronics*, pp. 52-55, Feb. 8, 1963.
- Celinski, O., Jelonek, Z. J., and Syski, R., "Pulling Effect in Synchronized Systems," *Proc. IEE (London)*, Vol. 101, pp. 50-52, 1954.

- Cessna, J. R., and Leavy, M. D., "Phase Noise and Transient Times for a Binary Quantized Digital Phase Locked Loop in White Gaussian Noise," *IEEE Trans. Commun.*, Apr. 1972.
- Cessna, J. R., *Bit Error Rates and Transient Times for a Binary Digital Loop Bit Synchronizer in Additive White Gaussian Noise*, Iowa University, Iowa City, Ia., Aug. 1970.
- Cessna, J. R., "Steady State and Transient Analysis of a Digital Bit Synchronization Phase-Locked Loop," *Proc. IEEE International Conference on Communications*, San Francisco, Calif., Vol. 2, pp. 34-15 to 34-19, June 8-10, 1970.
- Chadima, G. E., "Passive Satellite Tracking Radar Employing a 50% Duty Cycle and a Phase-Lock Receiver," *Proc. 1962 National Symposium on Space Electronics and Telemetry*, Oct. 1962.
- Chalkley, H. B., *False Lock in Sampled-Data Phase Lock Loops*, University Microfilms, Virginia Polytechnic Institute, Blacksburg.
- Chance, B., et al., *Waveforms*, MIT Rad. Lab. Series, Vol. 19, pp. 511-524, McGraw-Hill Book Co., Inc., New York, 1949.
- Chang, S. S. L., and Harris, B., "An Optimum Self-Synchronized Communication System," *Trans. Amer. Inst. Elec. Eng., Part I*, Vol. 81, pp. 110-116, 1962.
- Charles, F. J., *A Second Order Phase-Locked Loop Study*, TS No. 3341-65-3, Feb. 1966 (JPL internal document). Also M.S. thesis, Syracuse University, Sept. 1965.
- Charles, F. J., and Larson, F. L., "Spacecraft Telemetry and Command," *ITS Supporting Res. Adv. Develop.*, pp. 339-353, Feb. 28, 1967.
- Charles, F. J., and Lindsey, W. C., "A Model Distribution for the Phase Error in Second-Order Phase-Locked Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-14, pp. 662-664, Oct. 1966.
- Charles, F. J., and Lindsey, W. C., "Some Analytical and Experimental Phase-Locked Loop Results for Low Signal-to-Noise Ratios," *Proc. 17th International Astronautical Congress*, Madrid, Spain, Vol. 1, Oct. 9-15, 1966. Also *Proc. IEEE*, Vol. 54, pp. 1152-1166, Sept. 1966.
- Chelyshev, K. B., "Effect of External Noise on a Phase-Locked Oscillator," *Automatika i Telemekhanika*, Vol. 24, No. 7, pp. 942-949, July 1962.
- Chen, C., "An Analysis of Performance of Phase-Locked Loop Susceptible to Interference and Noise," *Digest of Technical Papers, IEEE Int. Commun. Conf.*, Philadelphia, Pa., pp. 212-213, June 1966.
- Chiang, C., *The Lock-In Range of an Automatic Phase Control System with Nonlinear Reactance-Tube Characteristics*, N69-11053, Air Force Systems Command (Foreign Technology Division), Wright-Patterson AFB, Ohio, Jan. 10, 1968.
- Choate, R. L., *Analysis of a Phase-Modulation Communication System*, JPL Progress Report PR-30-21, Jet Propulsion Laboratory, Pasadena, Calif., Oct. 8, 1959.
- Choate, R. L., "Analysis of a Phase-Modulation Communications System," *Trans. IRE*, Vol. CS-8, pp. 221-227, Dec. 1960.

- Choate, R. L., "Design Techniques for Low-Power Telemetry," Paper 3-1, *Proc. 1962 Nat. Telem. Conf.*, May 1962.
- Choate, R. L., and Sydnor, R. L., "Design of PM Communication Systems," *Trans. IRE*, Vol. SET-8, pp. 117-123, June 1962.
- Clapp, J. K., and Lewis, F. D., "A Unique Standard-Frequency Multiplier," *IRE National Convention Record*, Part 5, 1957.
- Clarke, C. E., et al., *Phase-Lock Studies*, Vols. I and II, Philco Reports RPAG21-6-1 and 6-2, Apr., Aug. 1961.
- Clarke, C. E., Golay, J. J. E., and Urban, S. J., *Phase Lock Studies*, Vol. III, Philco Research Division, Blue Bell, Pa., Oct. 27, 1961.
- Clarke, J. M., Otero, R. J., and Wanbaugh, W. C., "Pulse Interference Effects in a Phase-Lock Loop," Records of the *11th Electromagnetic Compatibility Symposium*, Asbury Park, N. J., pp. 207-214, June 17-19, 1969.
- Clarke, K. K., Pickholtz, R. L., and Schilling, D. L., *A Space Communications Study Progress Report*, Polytechnic Institute of Brooklyn, New York, Sept. 15, 1967-Mar. 15, 1968.
- Clarke, K. K., Tepedelenlioglu, N., and Unkauf, M., "The Frequency Locked Loop," *ITS Microwave Res. Inst. Programs*, Nov. 1967.
- Cleland, L. L., "Experimental Results on Phase Locked Loops with Added Non-linearities," *Mervin J. Kelly Commun. Conf.*, University of Missouri-Rolla, Oct. 5-7, 1970.
- Cleland, L. L., *Improvement of Phase-Locked Loops by the Introduction of Non-linearities*, University Microfilms, Purdue University, Lafayette, Ind.
- Cleland, L. L., and Leon, B. J., "Phase-Locked Loops for Large Signal Tracking," *Proc. 11th Midwest Symposium on Circuit Theory*, University of Notre Dame, Ind., May 13-14, 1968.
- Cobb, R. F., and Martin, A. R., "A Guide to Acquisition Receiver Selection Performance," *Microwave J.*, pp. 63-68, June 1968.
- Collinet, J. C. R., Hines, M. E., and Ondria, J. G., "FM Noise Suppression of an Injection Phase-Locked Oscillator," *IEEE Trans. Microwave Theory Tech.*, Vol. MTT-16, pp. 738-742, 1968.
- Compton, R. T., Jr., *The Effect of a Pure Time Delay on the Stability of a Phase-Lock Loop*, Interim Report, N66-26382, Ohio State University Research Foundation, Columbus, Ohio, Feb. 1966.
- Costas, J. P., "Some Notes on Space Communications," *Proc. IRE*, Vol. 47, pp. 1383-1385, 1959.
- Costas, J. P., "Synchronous Communications," *Proc. IRE*, Vol. 44, pp. 1713-1718, Dec. 1956.
- Costas, J. P., "Synchronous Detection of Amplitude-Modulated Signals," *Proc. Nat. Electron. Conf.*, Vol. 7, pp. 121-129, 1951.
- Couch, L. W., "A Study of a Driven Oscillator with FM Feedback by Use of a Phase-Locked-Loop Model," *IEEE Trans. Microwave Theory Tech.*, Vol. MTT-19, pp. 357-366, 1971.

- Couch, L. W., and Johnson, R. C., *The Analysis of Synchronized Oscillators by Use of Phase-Locked-Loops*, Summary Report, Florida University, Gainesville, Oct. 6, 1969.
- Craft, R., Reamer, E. D., and Young, J. R., "Detection and Measurement of Cycle Skipping and Phase Offsets in Frequency Multiplying Phase-Lock Filters," in *IEEE New Links to New Worlds*, National Space Electronics Symposium, 1963.
- Crafts, C. A., "Phase Multilock Communication," *Conf. Proc. 2nd Nat. Conv. on Mil. Electron.*, Washington, D. C., pp. 262-265, June 1958.
- Crow, R. B., and Tausworthe, R. C., *Practical Design of Third-Order Phase-Locked Loops*, Memo 900-450, Apr. 1971 (JPL internal document).
- Curtis, C. F., and Duncan, J. D., *FM Receiver Sensitivity Improvement Studies*, X70-76800, Final Report, Montana State College, Bozeman, Mont., July 1970.
- Daley, T. J., *Improved Phase Locked Loop Receiver*, NASA Tech Brief 68-10008, National Aeronautics and Space Administration, Washington, D. C., Jan. 1968.
- Davenport, W. B., Jr., "Signal-to-Noise Ratios in Band-Pass Limiters," *J. Appl. Phys.*, Vol. 24, pp. 720-727, June 1953.
- Davies, G. L., *A Narrow-Band Tracking Filter and Frequency Multiplier*, Technical Note TD 50, Royal Aircraft Establ., May 1960.
- De Bellescize, H., "La Reception Synchrone," *Onde Elec.*, Vol. 11, pp. 230-240, 1932.
- Debey, A. L., and Richard, V. W., "The Doploc Dark Satellite Tracking System," *Proc. Army Science Conference*, West Point, N. Y., June 1962, Vol. 1, pp. 199-210, Sept. 1962.
- de Bey, L. G., "Tracking in Space by DOPLOC," *Trans. IRE*, Vol. MIL-4, pp. 332-334, Apr.-July 1960.
- De Couvreur, G., and Ludwig, D., "A General Solution for the Shortest Acquisition Time in Type-II Phase-Lock Loops," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-4, pp. 639-640, 1968.
- De Russo, P. M., Michaels, L. H., and Tuel, W. G., Jr., *Design and Stability of Phase Locked Loops*, Final Report, Rensselaer Polytechnic Institute, Troy, N. Y., Dec. 1, 1964.
- Develet, J. A., "Coherent FDM/FM Telephone Communication," *Proc. IRE*, Vol. 50, No. 9, pp. 1957-1966, 1962.
- Develet, J. A., *Coherent FDM/FM Telephone Communication*, Technical Report No. 8614-6004-NU-000, Space Technol. Lab., Los Angeles, Calif., Jan. 1, 1962.
- Develet, J. A., *Fundamental Sensitivity Limitations for Second-Order Phase-Lock Loops*, Report 8616-0002-NU-000, Space Technology Laboratory, Los Angeles, Calif., June 1961.
- Develet, J. A., *The Influence of Time Delay on Second-Order Phase-Lock Loop Acquisition Range*, Report No. 9332.6-9, Space Technology Laboratory, Inc., Los Angeles, Calif., Sept. 1962.

- Develet, J. A., *Statistical Design and Performance of High-Sensitivity Frequency-Feedback Receivers (U)*, AD-408 639, Aerospace Corp., Los Angeles, Calif., May 1963.
- Develet, J. A., Jr., "An Analytic Approximation of Phase-Lock Receiver Threshold," *IEEE Trans. Space Electron. Telem.*, Vol. SET-9, pp. 9-11, Mar. 1963.
- Develet, J. A., Jr., *Fundamental Sensitivity Limitations for Second Order Phase-Lock Loops*, AD-416 683, TRW Space Technology Laboratories, Los Angeles, Calif., 1964.
- Develet, J. A., Jr., "The Influence of Time Delay on Second-Order Phase-Lock Loop Acquisition Range," *Proc. International Telemetry Conference*, London, England, Sept. 23-27, 1963, Institution of Electrical Engineers (London), Vol. 1, pp. 432-437, 1963.
- Develet, J. A., Jr., "A Threshold Criterion for Phase-Lock Demodulator," *Proc. IEEE*, Vol. 51, pp. 349-356, Feb. 1963; correction: p. 580, Apr. 1963.
- de Waal, J. J., *On the Establishment of Reference Signal of Partial Coherent Demodulation*, European Space Research Organization, Ph.D. Dissertation, Enchede, Netherlands, Feb. 1971.
- Dewan, E. M., "Harmonic Entrainment of Van der Pol Oscillations; Phaselocking and Asynchronous Quenching," *IEEE Trans. Automat. Contr.*, Vol. AC-17, No. 5, Oct. 1972.
- Didday, R. L., and Lindsey, W. C., "Subcarrier Tracking Methods and Communication System Design," *IEEE Trans. Commun. Technol.*, Vol. COM-16, No. 4, pp. 541-550, 1968.
- Dishington, R. H., "Diode Phase Discriminators," *Proc. IRE*, Vol. 37, pp. 1401-1404, Dec. 1949.
- Dollard, P. M., and Jacobs, I., *Weak-Signal Communication Techniques (U)*, AD-299 219, Bell Telephone Lab., Inc., Whippany, N. J., Apr. 1962.
- Dominiak, K. E., and Pickholtz, R. L., "Transient Behavior of a Phase-Locked Loop in the Presence of Noise," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 452-456, 1970.
- Doppler Tracking Loop Optimization Study*, AD-408 920, Philco Corp., Palo Alto, Calif., Dec. 1962.
- Dorf, R. C., and Shaft, P. D., "Minimization of Communication-Signal Acquisition Time in Tracking Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 495-499, 1968. Also *Proc. National Electronics Conference*, Chicago, Ill., Vol. 23, pp. 588-592, 1967.
- Dorf, R. C., and Shaft, P. D., "Reduction of Communication Signal Acquisition Time Through Nonlinear Design," *Proc. National Electronics Conference*, Chicago, Ill., Vol. 23, Oct. 23-25, 1967.
- Drogen, E. M., "Steering a Course to Safer Air Travel," *Electronics*, pp. 95-102, Nov. 1967.
- Dye, R. A., "Phase-Lock Loop Swept-Frequency Synchronization Analysis," Record of the 1965 *International Symposium on Space Electronics*, Miami Beach, Fla., Nov. 2-4, 1965.

- Easterling, M., *A Long-Range Precision Ranging System*, Technical Report 32-80, Jet Propulsion Laboratory, Pasadena, Calif., July 10, 1961.
- Edson, W. A., "Noise in Oscillators," *Proc. IRE*, Vol. 48, pp. 1454-1467, Aug. 1960.
- Edwards, K. A., Golubjatnikov, O., and Brady, D. J., "Transistor Phaselocked Oscillators," *AIEE Commun. Electron.*, pp. 1043-1051, Jan. 1959.
- Eisenberg, B. R., "Gated Phase-Locked Loop Study," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-7, pp. 469-477, May 1971.
- Ellis, M. E., and Sage, G. F., "Optimum Control Loop Design for Synchronous FM TONE Demodulators," *Proc. 1966 National Telemetry Conference*, Boston, Mass., May 10-12, 1966.
- Enloc, L. H., and Rodda, J. L., "Laser Phase-Locked Loop," *Proc. IEEE*, Vol. 53, No. 2, pp. 165-166, 1965.
- Esposito, R., and Mullen, J. A., "Noise in Oscillators with General Tank Circuits," *IRE Conv. Rec.*, Part 4, pp. 202-208, 1961.
- Evtyanov, S. I., and Snedkova, V. K., "Dependence of the Hold-In Range of a Phase Lock AFC System on the Characteristics of the Phase Detector with Proportional Plus Integral Filter," *Telecommun. Radio Eng.*, Part 2, Vol. 24, No. 4, 1969.
- Fath, G. R., *Functional Analysis of Phase Locked Loops*, Syracuse University, New York (microfilm).
- Feistel, C. H., and Gregg, W. D., *A Unified Performance Analysis of Adaptive and Self-Synchronizing Receiving Systems*, Texas University, Austin, Tex., Mar. 24, 1969.
- Felch, E. P., and Israel, J. O., "A Simple Circuit for Frequency Standards Employing Overtone Crystals," *Proc. IRE*, Vol. 43, pp. 596-603, May 1955.
- Feller, W., *An Introduction to Probability Theory and Its Applications*, Vol. I, John Wiley & Sons, Inc., New York, 1957.
- Fey, L., Atkinson, W. R., Newman, J., and Malling, L., "Obscurities of Oscillator Noise," *Proc. IEEE*, Vol. 52, pp. 104-106, Jan. 1964.
- Filippi, C. A., *Advanced Threshold Reduction Techniques Study*, N67-16668, ADCOM, Inc., Cambridge, Mass., Jan. 1967.
- Finden, H. J., "The Problem of Frequency Synthesis," *J. Brit. Inst. Radio Eng.*, Vol. 21, No. 1, pp. 95-103, 1961.
- Fleischmann, H. H., and Leonhardt, R., *Pull-In Range of General Phase Lock Circuits with One Large Time Constant*, Report No. GA 7564, John Jay Hopkins Laboratory for Pure and Applied Science, Gulf General Atomic, San Diego, Calif., Dec. 1966.
- Fralick, S., Mumma, J., and Develet, J., *The Analysis of Advanced Synchronous Telemetry Techniques (U)*, Final Report, AD-631 857, TRW Space Technol. Labs., Los Angeles, Calif., Oct. 1961.

- Frank, J., Newton, A., and Pugliese, L., "Solid State, Phase-Locked, Tunable UHF Power Oscillator," *Proc. 10th Annual East Coast Conference on Aerospace and Navigational Electronics*, Baltimore, Md., pp. 3.3.2 to 3.3.2-8, Oct. 1963.
- Frank, R. L., and Nick, R. W., "Interference Vulnerability of Phase-Lock Loops with Amplitude Limiting and Sampling," *Records of EASCON '69*, Washington, D. C., pp. 62-74, Oct. 27-29, 1969.
- Frankle, J., "Threshold Performance of Analog FM Demodulators," *RCA Rev.*, Vol. 27, pp. 521-562, Dec. 1966.
- Frankle, J., Heinemann, H., and Newton, A., "Multiple-Loop Frequency-Compressive Feedback for Angle-Modulation Detection," *RCA Rev.*, Vol. 29, pp. 252-269, 1968.
- Frankle, J., Lefrak, F., Mehlman, S., and Newton, A., "Phase Locked FM Demodulator for 600 Channel FDM," *8th Conv. on Mil. Electron.*, Washington, D. C., Sept. 1964.
- Frazier, J. P., and Page, J., "Phase-Lock Loop Frequency Acquisition Study," *IRE Trans.*, SET-8, pp. 210-227, Sept. 1962.
- Frenkel, G., "Oscillator Stability and the Second-Order Phase-Locked Loop," *IEEE Trans. Space Electron. Telem.*, Vol. SET-10, pp. 65-69, June 1964.
- Frenkel, G., *The Performance of Carrier-Tracking Loops*, Report No. R-241303-1-2, prepared for the Defense Communications Agency by System Sciences Corp., under Contract No. DCA-100-67-C-0023, Mar. 15, 1967.
- Fritchman, B., *Digital Equivalent Transreceiver Study*, Technical Report TR-68-539, AD 851 364, Rome Air Development Center, Griffiss Air Force Base, N. Y., Mar. 1969.
- Fujii, A., and Osatake, T., "FM Reception by a Parametric Tracking Filter," *Electronics and Communications in Japan*, Vol. 53, pp. 98-106, Jan. 1970 (translation).
- Gagliardi, R. M., "Error Probabilities in PCM/FM with Phase-Lock Loop Discriminators," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-2, pp. 608-611, Sept. 1966.
- Gardner, F. M., "DOPLOC Uses Phase-Locked Filter," *Electronic Industries*, Vol. 18, pp. 96-99, Oct. 1959.
- Gardner, F. M., *Phaselock Techniques*, John Wiley & Sons, Inc., New York, 1966.
- Gardner, F. M., "Stability of a Simple Phase-Lock Loop," *Proc. IEEE*, Vol. 58, pp. 1953-1954, 1970.
- Gardner, F. M., Kent, S. S., and Dasenbrock, R. D., *Theory of Phaselock Techniques*, N66-10515, Resdel Engineering Corp., Pasadena, Calif., 1966.
- Garodnick, J., Greco, J., and Schilling, D. L., "An All Digital Phase Locked Loop for FM Demodulation," *Proc. IEEE International Conference on Communications*, June 1972.
- Garodnick, J., Greco, J., and Schilling, D. L., "Design of an All Digital FM Discriminator," *Conv. Rec. FEC*, pp. 398-399, Fall 1971.

- Gee, T. H., *An Analytical and Experimental Investigation of a Frequency-Shift-Keyed Signal Generated by a Phase-Locked-Loop with Application to Narrow-band FSK*, University Microfilms, Virginia Polytechnic Institute, Blacksburg, Va.
- George, T. S., "Analysis of Synchronizing Systems for Dot-Interlaced Color Television," *Proc. IRE*, Vol. 38, pp. 124-131, Feb. 1951.
- Gilbert, A. L., and Osborne, W. P., "Phase Lock Loop Acquisition of a Carrier Modulated by a Single Sinusoid," Technical Papers of the 22nd Annual Southwestern Conference and Exhibition, Dallas, Tex., pp. 205-208, Apr. 22-24, 1970.
- Gilchriest, C. E., *The Application of Phase-Locked Loop Discriminators for Threshold Improvement and Error Reduction in FM/FM Telemetry*, JPL External Publication No. 364, Jet Propulsion Laboratory, Pasadena, Calif., Jan. 7, 1957.
- Gilchriest, C. E., "Application of the Phase-Locked Loop to Telemetry as a Discriminator or Tracking Filter," *Trans. IRE*, Vol. TRC-4, pp. 20-35, June 1958.
- Gilchriest, C. E., *Design and Operations Handbook for Phase-Locked Loop Discriminator*, JPL Publication No. 127, Jet Propulsion Laboratory, Pasadena, Calif., May 30, 1958.
- Gilchriest, C., Goldstein, R., and Mathison, R., *Telemetry Receiver*, NASA Tech Brief 70-10008, National Aeronautics and Space Administration, Washington, D. C., Aug. 1970.
- Gill, G. S., and Gupta, S. C., "First Order Discrete Phase Locked Loop with Applications to Demodulation of Angle-Modulated Carrier," *IEEE Trans. Commun.*, June 1972.
- Gill, G. S., and Gupta, S. C., "On Higher Order Discrete Phase Locked Loop," *IEEE Trans. Aerosp. Electron. Syst.*, Sept. 1972.
- Gill, W. J., "A Comparison of Binary Delay-Lock Tracking-Loop Implementations," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-2, pp. 415-424, July 1966.
- Glenn, A. B., "Mars Voyager-Lander Direct Link Communications System," *RCA Eng.*, Vol. 12, pp. 70-74, 1967.
- Golay, M. J. E., "The Application of Radio Interferometry to Extraterrestrial Metrology," *Trans. IRE*, Vol. SET-5, pp. 186-193, Dec. 1959.
- Golay, M. J. E., "Automatic Frequency Control," *Proc. IRE (Correspondence)*, Vol. 40, p. 996, 1952.
- Golay, M. J. E., "Monochromaticity and Noise in a Regenerative Electric Oscillator," *Proc. IRE*, Vol. 48, pp. 1473-1477, Aug. 1960.
- Golay, M. J. I., "Normalized Equations of the Regenerative Oscillator-Noise, Phase-Locking, and Pulling," *Proc. IEEE*, Vol. 52, pp. 1311-1330, 1964.
- Goldstein, A. J., "Analysis of the Phase-Controlled Loop with a Sawtooth Comparator," *Bell Syst. Tech. J.*, pp. 603-633, Mar. 1962.
- Goldstein, A. J., and Byrne, C. J., "The Phase-Controlled Loop with a Sawtooth Comparator," Convention Records of the *Northeast Electron. Res. Eng. Meeting*, Boston, Mass., Nov. 1960.

- Goldstein, A. J., and Byrne, C. J., "Pull-in Frequency of the Phase-Controlled Oscillator," *Proc. IRE*, Vol. 49, p. 1209, July 1961.
- Goldstein, R., *The Minimization of Oscillator Noise*, Research Summary 36-14, pp. 61-63, Jet Propulsion Laboratory, Pasadena, Calif., May 1, 1962.
- Goto, H., "A Digital Phase-Locked Loop for Synchronizing Digital Networks," Conf. Rec. *IEEE International Conference on Communications*, San Francisco, Calif., 70-CP-362-COM, p. 34-20, 1970.
- Graefe, P. W. U., and Loh, N. K., "Stability Criteria of Phase-Locked Loops," *Proc. 3rd Annual Allerton Conference on Circuit and System Theory*, University of Illinois, Monticello, Ill., Oct. 20-22, 1965.
- Gray, R. M., and Tausworthe, R. C., "Frequency-Counted Measurements and Phase Locking to Noisy Oscillators," *IEEE Trans. Commun. Technol.*, Vol. COM-19, pp. 21-30, 1971.
- Greenhouse, S. C., "Degradation of the Performance of a First-Order Phase-Locked Loop Due to Interference," Records of *International Symposium on Electromagnetic Compatibility*, Anaheim, Calif., pp. 21-29, July 14-16, 1970.
- Grivet, P., and Blaquiere, A., "Non-Linear Effects of Noise in Electronic Clocks," *Proc. IEEE*, Vol. 51, pp. 1606-1614, Nov. 1963.
- Gruen, W. J., "Theory of AFC Synchronization," *Proc. IRE*, Vol. 41, pp. 1043-1048, Aug. 1953.
- Guers, K., "Modulation and Mode Locking of the Continuous Ruby Laser," *IEEE J. Quantum Electron.*, Vol. 3, pp. 175-180, 1967.
- Gumacos, C., "Analysis of an Optimum Sync Search Procedure," *IEEE Trans. Commun. Syst.*, Vol. 11, No. 1, pp. 89-99, Mar. 1963.
- Gunigal, T. E., and Santarpia, D. E., *A Digital Voltage-Controlled Oscillator for Phase-Locked Loops*, N68-24389, NASA Goddard Space Flight Center, Greenbelt, Md., May 1968.
- Gupta, S. C., "On Optimum Digital Phase-Locked Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 340-344, Apr. 1968.
- Gupta, S. C., "Status of Digital Phase Locked Loops," *Proc. Hawaii Conference*, Jan. 1970.
- Gupta, S. C., "Transient Analysis of a Phase-Locked Loop Optimized for a Frequency Ramp Input," *IEEE Trans. Space Electron. Telem.*, Vol. SET-10, pp. 79-84, June 1964.
- Gupta, S. C., Bayless, J. W., and Hummels, D. R., "Threshold Investigation of Phase-Locked Discriminators," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-4, No. 6, pp. 855-863, 1968.
- Gupta, S. C., and Sanneman, R. W., "Optimum Strategies for Minimum Time Frequency Transitions in Phase-Locked Loops," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-2, pp. 570-581, Sept. 1966.
- Gupta, S. C., and Solem, R. J., "Optimum Filters for Second- and Third-Order Phase-Locked Loop for FM Television," *IEEE Trans. Space Electron. Telem.*, Vol. SET-11, pp. 54-62, June 1965.
- Gutleber, F. S., *Threshold Extension Revisited*, X70-13813, Army Electronics Command, Fort Monmouth, N. J., Jan. 1970.

- Haag, J., "Sur les Oscillations Auto-Entretenues," *Comptes Rendus de l'Academie des Sciences (Paris)*, Vol. 199, pp. 906-909, 1934; "Sur l'Etude Asymptotique des Oscillations de Relaxation," *ibid.*, Vol. 202, pp. 102-104, 1936; "Sur la Theorie Des Oscillations de Relaxation," *ibid.*, Vol. 204, pp. 932-934, 1937; "Formules Asymptotiques Concernant les Oscillations de Relaxation," *ibid.*, Vol. 206, pp. 1235-1237, 1938.
- Halliday, D., "A Review of Some Phase Locked Loop Theory," *Proc. International Communication Conference*, Montreal, Canada, pp. 3-2 to 3-8, 1971.
- Hammond, W. M., and Stewart, T. L., "A Model Distribution for a Hybrid Phase-Locked Loop," Report on the 3rd Asilomar Conference on Circuits and Systems, Pacific Grove, Calif., Dec. 10-12, 1969, pp. 149-152.
- Hannan, W., and Olson, T., "An Automatic Frequency Controlled Phase Shift Keyed Demodulator," *RCA Rev.*, Vol. 22, pp. 729-752, Dec. 1961.
- Harrison, R., "Analysis of the Statistics and Threshold of the Phase-Lock Loop," *IEEE Proc.*, Vol. 116, No. 1, pp. 43-52, Jan. 1969.
- Hartl, P., "Das Prinzip des 'Phase-Locked Loop' und seine Anwendung in Nachrichten-Empfaengern fuer die Raumfahrt," *Raumfahrtforschung*, Vol. 6, pp. 55-64, 1966.
- Hartl, P., "The Phase Locked Loop Principle and Its Application to Communication Receivers for Space Flight," *Raumfahrtforschung*, Vol. 8, pp. 55-64, Apr.-June 1964.
- Hata, M., and Iwano, T., "Direct Regenerative Phase-Locked Loop—A New Carrier Synchronization System," *Electron. Commun. Jap.*, Vol. 52, pp. 15-24, Sept. 1969 (translation).
- Hayes, J. F., and Sergo, J. R., Jr., "Analysis and Simulation of a PN Synchronization System," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 676-679, 1970.
- Hayre, H. S., "Doppler Tracking Radar Systems," *Electronics and Telecommunication Engineering Division, India*, Vol. 51, pp. 169-172, 1970.
- Heckert, G. P., *Design of Phase-Locked FM Demodulators for Maximum Sensitivity*, TR 102, Philco Western Development Laboratories (to be published).
- Heckert, J. P., *Study of the Phase-Locked Loop for Doppler Tracking (U)*, AD-287107, Philco Corp., Palo Alto, Calif., 1963.
- Heinemann, H., and Tepfer, A., *Study, Investigation, Design and Development of a Demodulator*, Quarterly Progress Report, Radio Corporation of America, New York, Sept. 1-Nov. 30, 1966.
- Heinemann, H. N., "Threshold Extension Applied to Single Channel FM Receivers," *Conf. Proc. 8th Int. Conv. Mil. Electron.*, Washington, D. C., Sept. 1964.
- Henderson, R. E., "Measuring the Doppler Frequency Shift on Satellite Transmissions," *Brit. Commun. Electron.*, Vol. 8, No. 7, pp. 506-512, 1961.
- Hennick, R. P., "Use This Tan-Lock Demodulator," *Electronic Design*, Vol. 18, pp. 74-75, Dec. 6, 1970.
- Herold, W., "The Locking Behavior of a Phase-Locked Loop With a Sawtooth Comparator," *Archiv Fuer Elektronik Und Uebertragungstechnik*, Vol. 25, pp. 226-300, May 1971 (in German).

- Hess, D., "Comments on Threshold Investigation of Phase-Locked Discriminators," *IEEE Trans. (Correspondence)*, Vol. AES-5, pp. 877-878, 1969.
- Hess, D. T., "Cycle Slipping in a First-Order Phase-Locked Loop," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 255-260, 1968. Also *ITS Microwave Res. Inst. Programs*, Nov. 1967.
- Hess, D. T., "Equivalence of FM Threshold Extension Receivers," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 746-748, 1968.
- Hess, D. T., and Schwartz, B., "Cycle Slipping in a Second Order Phase Locked Loop," *ITS Microwave Res. Inst. Programs*, Nov. 1967.
- Hetzheim, H., "The Method of Chronological Ordering of Operators for the Calculation of Nonlinear Unsteady Systems," *Hochfrequenztechnik Und Elektroakustik*, Vol. 80, pp. 55-73, Apr. 1971 (in German).
- Highleyman, W. H., and Jacob, E. S., "An Analog Multiplier Using Two Field Effect Transistors," *Trans. IRE*, Vol. CS-10, pp. 311-317, Sept. 1962.
- Hill, E. R., *Techniques for Synchronizing Pulse-Code-Modulated Telemetry (U)*, AD-402 192, Naval Ordnance Laboratory, Corona, Calif., Feb. 1963.
- Hirade, K., Kondo, S., and Kuramoto, M., "Configuration and Performance of Phase Locked Loop Composed of Three Subloops," *ITS Electron. Commun. Lab. Tech. J.*, Vol. 19, No. 2, pp. 87-102, 1970.
- Hirade, K., and Kuramoto, M., "Design of Phase Locked Loop with Time Delay," *ITS Electron. Commun. Lab. Technol. J.*, Vol. 19, No. 2, pp. 73-86, 1970.
- Hiroshige, K., "A Simple Technique for Improving the Pull-In Capability of Phase-Lock Loops," *IEEE Trans. Space Electron. Telem.*, Vol. SET-11, pp. 40-46, Mar. 1965.
- Hoffman, E., and Schilling, D. L., "Threshold of the FMFB," *Proc. Int. Commun. Conf.*, Boulder, Colo., 1969.
- Hoffman, L. A., *Receiver Design and the Phase Lock Loop*, Aerospace Corp., El Segundo, Calif., May 1963. (Booklet prepared for Electronics and Space Exploration Technical Lecture Series, Sponsored by IEEE.)
- Holmes, J., "A Simulation Study of the First Slip Times Versus the Static Phase Offset for First- and Second-Order Phase-Locked Loops," in *The Deep Space Network*, Space Programs Summary 37-58, Vol. II, pp. 29-32, Jet Propulsion Laboratory, Pasadena, Calif., July 31, 1969.
- Holmes, J. K., "Coding and Synchronization Studies: On Solution to the Second-Order Phase-Locked Loops," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 182-186, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.
- Holmes, J. K., "First Slip Times Versus Static Phase Error Offset for the First- and Passive Second-Order Phase-Locked Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-19, pp. 234-235, 1971.
- Holmes, J. K., "Performance of a First Order Transition Sampling Digital Phase Locked Loop Using Random Walk Models," *IEEE Trans. Commun.*, Apr. 1972.

- Holmes, J. K., "Random Walk Techniques in the Solution of First Order Digital Phase-Locked Loops," *Proc. Fourth Hawaii International Conference on System Sciences*, University of Hawaii, Honolulu, pp. 664-666, Jan. 12-14, 1971.
- Holmes, J. K., "On a Solution to a Digital First Order Phase Lock Loop," *Mervin J. Kelly Commun. Conf.*, University of Missouri-Rolla, Oct. 1970.
- Holmes, J. K., "On a Solution to the Second-Order Phase-Locked Loop," *IEEE Trans. Commun. Technol.*, Vol. COM-18, No. 2, pp. 119-126, 1970.
- Holmes, J. K., "Stationary and Nonstationary Phase Distributions for the Practical Second-Order Phase-Locked Loop," in *Supporting Research and Advanced Development*, Space Programs Summary 37-49, Vol. III, pp. 297-300, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 29, 1968.
- Holtzman, J. M., and Rue, A. K., "Regions of Asymptotic Stability for Phase-Lock Loops," *IEEE Trans. Space Electron. Telem.*, Vol. SET-10, pp. 45-46, Mar. 1964.
- Holzmann, E. G., "Pulsed Phase-Locked Loops," *Proc. 4th Joint Automatic Control Conference*, University of Minnesota, Minneapolis, Minn., pp. 398-403, June 19-21, 1963.
- Huang, M. Y., and Stuber, F. M., *The Combline Filter and Phase-Lock Loop*, N70-34526, TRW Systems Group, Redondo Beach, Calif., May 1970.
- Huff, R. J., and Reinhard, K. L., "A Delay-Lock Loop for Tracking Pulsed-Envelope Signals," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-7, pp. 478-485, 1971.
- Hughen, J. H., and Lee, J. S., "An Optimum Phase Synchronizer in a Partially Coherent Receiver," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-7, pp. 652-661, 1971.
- Hummels, D. R., "Some Simulation Results for the Time to Indicate Phase Lock," *IEEE Trans. Commun. Technol.*, Vol. COM-20, No. 1, pp. 37-43, Feb. 1972.
- Hussein, A. W., *Phase-Error Statistics and a Second-Order Phase-Locked Loop and Design of an Optimum Decision Unit for Space Communications*, University Microfilms, Virginia Polytechnic Institute, Blacksburg.
- Huylar, J., Lawhorn, R., and Weaver, C. S., *Study of Adaptive Processes Applied to Phase-Locked Loops*, Tech. Doc. Rep., AD-609 242, Philco Corp., Palo Alto, Calif., Dec. 1961.
- Iceland, L., and Leon, J. B., *Improvement of Phase-Locked Loops by the Introduction of Nonlinearities*, Purdue University, Lafayette, Ind., 1968.
- Ignatov, Iu. F., "Statistical Analysis of the Accuracy of Phase-Locked AFC," *Telecommun. Radio Eng., Part II—Radio Eng.*, Vol. 23, pp. 86-92, 1968. Also *Radiotekhnika*, Vol. 23, pp. 36-44, Feb. 1968.
- Ignatov, Iu. F., and Shakhgildian, V. V., "The Effect of Noise on the Accuracy of a Phase-Locked AFC System," *Elektrosviaz'*, Vol. 20, Mar. 1966. Also *Telecommun. Radio Eng., Part I—Telecommun.*, Vol. 20, pp. 32-38, Mar. 1966.

- Ignatov, Iu. F., and Shakhgildian, V. V., "Synchronization Failure in a Phase-Lock Automatic Frequency Control System," *Elektrosviaz'*, Vol. 21, pp. 17-22, June 1967 (in Russian).
- Ingham, W. E., *The Design of an APC Synchronizing Loop*, Report No. RW/8, EMI Research Laboratory, Hayes, Middlesex, England, Apr. 1956.
- Inose, H., Saito, T., and Shibuya, T., "Design of Multiple-Input Phase-Locked Oscillator in Mutually Synchronized System," *Electronics Letters*, Vol. 6, pp. 468-469, 1970.
- Jaffe, R., and Rechlin, E., "Design and Performance of Phase-Lock Loops Capable of Near-Optimum Performance Over a Wide Range of Input Signal and Noise Levels," *Trans. IRE*, Vol. IT-1, pp. 66-76, Mar. 1955.
- Jankovich, J. L., "Phase-Locked Interferometer," *Proc. 16th Int. Astronaut. Congr.*, Athens, Greece, p. 33, Sept. 1965.
- Janky, J. M., "Nomograms Simplify Phase-Lock-Loop Analysis," *Microwaves*, Vol. 9, pp. 52-55, 1970.
- Jazwinski, A. H., *Stochastic Processes and Filtering Theory*, Academic Press, Inc., New York, 1970.
- Jelonek, F. J., and Khanu, A. H., "Synchronized Oscillatory Systems with Non-uniform Gain in the Feedback Loop," *Proc. IEE (Brit.)*, Vol. 113, No. 11, pp. 1769-1774, 1966.
- Jelonek, Z. J. and Cowan, C. J., "Synchronized Systems with Time Delay in the Loop," *Proc. IEE*, Vol. 104, Part C, pp. 389-397, 1957.
- Jelonek, Z., Celinski, O., and Syski, R., "Pulling Effect in Synchronized Systems," *Proc. IEE (Brit.)*, Vol. 101, Part 4, pp. 108-117, 1954.
- Jennings, R. R., and Miller, D. C., *A Low Noise Correlation Frequency Tracker*, AD-412, 630, Naval Avionics Facility, Indianapolis, Ind., Feb. 1962.
- Jensen, G. K., *An Active Filter*, Report No. 4630, Naval Research Laboratory, Washington, D. C., Nov. 10, 1955.
- Jochen, P., "Injection-Locked Oscillators," *Nachrichtentechnische Zeitschrift*, Vol. 23, pp. 537-541, Oct. 1970.
- Johnson, R. S., and Smith, A. E., "A Digital Simulation of a Phase Locked Receiver in a Fading Multipath Environment," Records of the *IEEE 7th Annual Region III Convention*, Cocoa Beach, Fla., pp. S4-2P1 to S4-2P13, Nov. 18-20, 1968.
- Johnson, W. A., *A General Analysis of the False-Lock Problem Associated with the Phase-Lock Loop*, Aerospace Corp., El Segundo, Calif., Oct. 2, 1963.
- Jones, T. J., "Error Rate Minimization for Improved Phase-Locked Loop Damping Characteristics," Technical Papers of the *22nd IEEE Annual Southwestern Conference and Exhibition*, Dallas, Tex., pp. 449-452, Apr. 22-24, 1970.
- Jones, T. J., "Phase-Locked Loop Optimization Based upon the Mean-Square Minimization of Error and Error Rate," *Mervin J. Kelly Commun. Conf.*, University of Missouri-Rolla, Oct. 1970.

Judd, L. F., *Sample Data Analysis of Digital Phased-Locked Loops*, M.S. thesis, Texas Technological University, Lubbock, 1967.

Kaehler, W., *Investigation of Bit Synchronization Methods for Data Transmission Over Noisy Channels*, Standard Elektrik Lorenz A. G., Stuttgart, West Germany, Mar. 1968.

Kapranov, M. V., "Asymptotic Method of Calculating the Lock-On Band of a Second-Order Phase-Locked Automatic Frequency Control with a Filter Containing a Nonlinear Capacitance," *Elektrosvyaz'*, Vol. 23, pp. 30-40, 1969 (in Russian).

Kapranov, M. V., "Band of Entrainment Asymptotic Value in Phase Frequency Control," *Izvestia Vysshiku Uchebnykh Zavedenii, Radiofizika*, Vol. 11, No. 7, pp. 1028-1040, 1968.

Kapranov, M. V., "The Effect of the Form of the Phase Detector Characteristics on the Asymptotic Capture Bandwidth of Phase Automatic Frequency Control," *Radio Eng. Electron. Phys.*, Vol. 14, No. 5, pp. 714-717, May 1969.

Kapranov, M. V., "Method of Calculating the Locking Range of a Phase Sensitive Automatic Frequency Control System," *Telecommunications*, Vol. 18, No. 8, pp. 13-22, Aug. 1963 (translation from Russian).

Kapranov, M. V., "Noise Filtering and Phase Locked Automatic Frequency Control," *Radio Eng. Electron. USSR*, Vol. 1, 1956.

Kapranov, M. V., *Radiotekhnika*, Vol. 11, No. 12, pp. 37-52, Dec. 1956.

Keblawi, P. S., "Probability Distribution of Time to Phase Lock for a Second-Order Phase-Locked Loop," *RCA Rev.*, Vol. 29, pp. 106-121, 1968.

Keblawi, P. S., "Unlock Behavior of the Second-Order Phase-Locked Loop With and Without Interfering Carriers," *RCA Rev.*, Vol. 28, pp. 277-296, June 1967.

Kelly, C. N., *Discrete Time Demodulation of Continuous Time Signals*, Ph.D. dissertation, Southern Methodist University, Dallas, Tex., May 1971.

Kelly, C. N., and Gupta, S. C., "The Digital Phase-Locked Loop as a Near Optimum FM Demodulator," *IEEE Trans. Commun. Technol.*, Vol. COM-20, No. 3, June 1972.

Kendall, W. B., Levy, G. S., Nixon, D. L., and Panson, P. L., "Data Processing Method for a Weak, Moving Telemetry Signal," *IEEE Trans. Instrum. Meas.*, Dec. 1968. Also NASA Tech Brief 69-10639, National Aeronautics and Space Administration, Washington, D. C., 1969.

Klapper, J., Aaronson, G., Acampora, A., Frankle, J., and McLaughlin, P., "Error Rates with Angular Feedback Demodulators," *IEEE Nat. Telem. Conf.*, Houston, Tex., Apr. 1968.

Klapper, J., and Creutz, J., "Minimization of Cycle Slipping Rate in a First Order PLL with Frequency Offset," *3rd Asilomar Conference on Circuits and Systems*, Pacific Grove, Calif., Dec. 1969.

Klapper, J., and Frankle, J. T., *Phaselocked and Frequency Feedback Systems*, Academic Press, Inc., New York, 1972.

- Klapper, J., and Rabinovici, B., *A Frequency Synthesizer Study for the Proposed AN/GRC-103*, RCA Report CR-62-419-8, AD 289 562, RCA Corp., July 1962.
- Kline, A. J., Jr., and Moore, W. C., "Concepts and Computational Techniques Used in the Design of Phase-Lock Circuits," *Proc. National Telemetry Conference*, Houston, Tex., Apr. 13-15, 1965.
- Kline, A. J., and Moore, W. C., "Phase-Lock Loops in Space Communications," *Instrum. Contr. Syst.*, Vol. 39, pp. 131-135, Sept. 1966.
- Koopman, B. O., "The Optimum Distribution of Searching Effort," *J. Oper. Res. Soc. Amer.*, Vol. 5, p. 613, 1957.
- Ku, Y. H., and Su, J. C. C., "Comparison of Variances Evaluated by Kolmogorov's and Volterra's Techniques," *Proc. IEEE*, Vol. 54, pp. 900-901, June 1966.
- Kurokawa, K., "Noise in Synchronized Oscillators," *IEEE Trans. Microwave Theory Tech.*, Vol. MTT-16, pp. 234-240, 1968.
- Labin, E., "Theory of Synchronization by Control of Phase," *Phillips Res. Rep.*, Vol. 4, pp. 291-315, Aug. 1949.
- La Frieda, J. R., "Transient Analysis of Nonlinear Tracking Systems," *Proc. National Electronics Conference*, Chicago, Ill., Vol. 26, pp. 762-767, Dec. 7-9, 1970.
- La Frieda, J. R., "Transient Solutions of the Fokker-Planck Equation for a Class of First-Order Phase-Locked Loops," *Proc. 4th Hawaii International Conference on System Sciences*, University of Hawaii, Honolulu, pp. 471-473, Jan. 12-14, 1971.
- Larimore, W. E., *Design and Performance of a Second-Order Digital Phase-Locked Loop*, Polytechnic Institute of Brooklyn, New York, Apr. 1969.
- Larimore, W. E., "Synthesis of Digital Phase-Locked Loops," *Records of EASCON '68*, Washington, D. C., pp. 14-20, Sept. 9-11, 1968.
- Laughlin, C. R., "The Diversity-Locked Loop—A Coherent Combiner," *IEEE Trans. Space Electron. Telem.*, Vol. SET-9, pp. 84-91, Sept. 1963.
- Laughlin, C. R., Jr., *Diversity Locked Loop as an Optimum Tracking Combiner*, X63-11218, NASA Goddard Space Flight Center, Greenbelt, Md., 1962.
- Lawhorn, R., and Weaver, C. S., "The Linearized Transfer Function of a Phase Locked Loop Containing an IF Amplifier," *Proc. IRE*, Vol. 49, p. 1704, Nov. 1961.
- Layland, J. W., "On the Optimum Correlation Function for a First-Order Tracking Loop," in *Supporting Research and Advanced Development*, Space Programs Summary 37-50, Vol. III, pp. 284-289, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 30, 1968.
- Layland, J. W., "On Optimal Signals for Phase-Locked Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-17, pp. 526-531, 1969.

- Layland, J. W., "An Optimum Squaring Loop Prefilter," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 695-697, 1970.
- "L-Band Ground Transmit-Receive System Used in the Transponder Helicopter Ranging Experiments," in *Deep Space Instrumentation Facility*, Space Programs Summary 37-18, Vol. III, pp. 53-64, Jet Propulsion Laboratory, Pasadena, Calif., Nov. 30, 1962.
- Lee, S. Y., and Nelson, L. D., *Tracking Analysis of a First Order Phase-Locked Loop with Two Sinewaves Modulation*, N71-17473, Bellcomm, Inc., Washington, D. C., Jan. 1, 1971.
- Leek, R., "Phase-Lock AFC Loops," *Electron. Radio Eng.*, pp. 141-146, Apr. 1957, and pp. 177-183, May 1957.
- Lehan, F. W., "Telemetry and Information Theory," *Trans. IRE*, Vol. TRC-2, pp. 15-19, Nov. 1954.
- Lehan, F. W., and Parks, R. J., "Optimum Demodulation," *IRE Nat. Conv. Rec.*, Part 8, pp. 101-103, 1953.
- Leskovar, B., "Essential Nonlinearity of Phase-Sensitive Detector Characteristics," *IEEE Trans. Instrum. Meas.*, Vol. IM-18, pp. 81-87, June 1969.
- Leskovar, B., "Generalized Analysis of Phase-Sensitive Detection-Circuit Operating Characteristics at the Signal Detection in the Presence of Noise," *IEEE Trans. Instrum. Meas.*, Vol. IM-21, No. 1, pp. 15-24, Feb. 1972.
- Leskovar, B., "Generalized Criteria of Characteristic Nonlinearity of Phase-Sensitive Detection Systems," *Proc. 3rd Hawaii Int. Conf. on Systems Sciences*, Honolulu, pp. 13-16, 1970.
- Leskovar, B., "Nonlinearity Minimums and Maximums of a Phase-Sensitive Detection System," *IEEE Trans. Instrum. Meas.*, Vol. IM-19, pp. 25-27, 1970.
- Leskovar, B., "Phase-Sensitive Detector Nonlinearity at the Signal Detection in the Presence of Noise," *IEEE Trans. Instrum. Meas.*, Vol. IM-16, pp. 285-294, Dec. 1967.
- Leslie, C. B., and Williams, K. G., *Analysis of a Coherent Detection Lock-In System*, Naval Ordnance Laboratory, White Oak, Md., Mar. 8, 1966.
- Lewis, P. H., and Weingarten, W. E., "A Comparison of Second, Third, and Fourth Order Phase-Locked Loops," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-3, pp. 720-727, July 1967.
- Liakhovkin, A. A., and Shakhgildian, V. V., "Filtering of a Monochromatic Signal by Phase-Locked Oscillator," *Elektrosviaz'*, Vol. 18, pp. 11-18, Apr. 1964 (in Russian).
- Lienard, A. M., "Oscillations Auto-Entretenues," *Proc. Third International Congress for Applied Mechanics*, Stockholm, Vol. 3, Part 3, pp. 173-177, Aug. 1930.
- Lienard, J. C., "The Phase Lock Loop—Linear Phenomena," *Revue Technique Cecles/Coru*, Vol. 1, No. 2, pp. 205-237, 1969.
- Lindauer, C. M., *Nonlinear Behavior/Analysis and Simulation of Several Second-Order Random-Modulated Phase-Locked Loops*, University Microfilms, Virginia Polytechnic Institute, Blacksburg.

- Lindenlaub, J. C., and McGillem, C. D., *Theoretical and Experimental Studies of Sub-Optimal Second and Third Generation Self-Adaptive Binary Communication System*, Semiannual Report, Purdue University, Lafayette, Ind., Jan. 1–June 30, 1966.
- Lindenlaub, J. C., and Olsen, D. P., *A Study of the Extended Linear Range Phase Lock Loop*, Report TR-EE68-27, Purdue University, Lafayette, Ind., Aug. 1968.
- Lindenlaub, J. C., and Urhan, J. J., "A Phase Lock Loop System with a Modulo 2π Phase Detector," *ITS Theoretical and Experimental Studies of Sub-Optimal Second and Third Generation Self-Adaptive Binary Communication Systems*, pp. 10–14, Dec. 31, 1966.
- Lindenlaub, J. C., and Urhan, J. J., *Threshold Study of Phase Lock Loop Systems*, Interim Technical Report, Purdue University, Lafayette, Ind., Dec. 1966. Also in *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 787–795, Dec. 1968.
- Lindenlaub, J. C., and Urhan, J. J., Jr., "The Effect of Phase Detector Characteristics on Phase Lock Loop Design Parameters," *International Symposium on Information Theory*, Los Angeles, Jan. 31–Feb. 2, 1966, Purdue University, Lafayette, Ind.
- Lindenlaub, J. C., and Urhan, J. J., Jr., "Experimental Results for Phase-Lock Loop Systems Having a Modified n th-Order Tanlock Phase Detector," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 787–795, 1968. Also *International Conference on Communications*, Minneapolis, Minn., June 12–14, 1967.
- Lindgren, A. G., Pinkos, R. F., and Berube, R. H., "Noise Dynamics of the Phase-Locked Loop with Signal Clipping," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-5, No. 1, pp. 66–76, 1969.
- Lindsey, W. C., "Block Coding for Space Communications," *IEEE Trans. Commun. Technol.*, Vol. COM-17, pp. 217–225, 1969.
- Lindsey, W. C., "Coding and Synchronization Studies: Dynamics of Second-Order Phase-Locked Loops," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 177–181, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.
- Lindsey, W. C., "Design and Performance of Block-Coded Communication Systems," *Proc. 1967 National Telemetry Conference*, San Francisco, Calif., May 16–18, 1967.
- Lindsey, W. C., "Frequency Demodulation," in *Supporting Research and Advanced Development*, Space Programs Summary 37-27, Vol. IV, pp. 198–204, Jet Propulsion Laboratory, Pasadena, Calif., June 30, 1964.
- Lindsey, W. C., "Hybrid Carrier and Modulation Tracking Loops," *Proc. International Conference on Communications*, San Francisco, Calif., Vol. 2, pp. 34–10 to 34-14, June 8–10, 1970.
- Lindsey, W. C., "Investigation of Second-Order Phase-Locked Loops by Fokker-Planck Methods," in *Supporting Research and Advanced Development*, Space Programs Summary 37-30, Vol. IV, pp. 262–268, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1964.
- Lindsey, W. C., "Nonlinear Analysis of Generalized Tracking Systems," *Proc. IEEE*, Vol. 57, No. 10, pp. 1705–1722, Oct. 1969.

- Lindsey, W. C., *Nonlinear Analysis and Synthesis of Generalized Tracking Systems*; Part I, USCEE317, Dec. 1968; Part II, USCEE342, Apr. 1969; University of Southern California, Los Angeles, Calif.
- Lindsey, W. C., "Optimum Frequency Demodulation," in *Supporting Research and Advanced Development*, Space Programs Summary 37-26, Vol. IV, pp. 227-234, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 30, 1964.
- Lindsey, W. C., "Phase Density Distribution of Phase-Locked Loops in Cascade," *IEEE Trans. Commun. Technol.*, Vol. COM-17, No. 4, p. 503, 1969.
- Lindsey, W. C., "Phase-Shift-Keyed Signal Detection with Noisy Reference Signals," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-2, No. 4, pp. 393-401, 1966.
- Lindsey, W. C., *Synchronization Systems in Communication and Control*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1972.
- Lindsey, W. C., "Threshold Characteristics in Phase-Locked Frequency Discriminators," in *Supporting Research and Advanced Development*, Space Programs Summary 37-28, Vol. IV, pp. 223-226, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 31, 1964.
- Lindsey, W. C., and Charles, F. J., "A Model Distribution for the Phase Error in Second Order PLL's," *IEEE Trans. Commun. Technol.*, Vol. COM-14, pp. 662-664, Oct. 1966.
- Lindsey, W. C., and Hayes, J. F., "Coding and Synchronization Studies: Power Application Length Into Rapidly Varying Phase Error," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 187-190, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.
- Lindsey, W. C., and Simon, M. K., "Data-Aided Carrier Tracking Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-19, pp. 157-168, 1971. Also *Symposium on Information Theory*, Noordwijk, The Netherlands, June 15-19, 1970.
- Lindsey, W. C., and Simon, M. K., "The Effect of Loop Stress on the Performance of Phase-Coherent Communication Systems," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 569-588, 1970.
- Lindsey, W. C., and Simon, M. K., *Telecommunication Systems Engineering*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1973.
- Lindsey, W. C., and Tausworthe, R. C., "A Survey of Phase-Locked Loop Theory," *IEEE Int. Commun. Conf.*, Minneapolis, Minn., June 1967.
- Lindsey, W. C., and Weber, C. L., "On the Theory of Automatic Phase Control," chapter in *Stochastic Optimization and Control*. Also *Proceedings of an Advanced Seminar*, University of Wisconsin, Madison, Wisc., Oct. 2-4, 1967.
- Loch, F. J., "Threshold Extension Techniques Using Impulse Noise Estimation," *Proc. National Electronics Conference*, Chicago, Ill., Vol. 25, pp. 545-549, Dec. 8-10, 1969.
- Long, L. L., and Rutledge, R. B., "A Digital Computer Simulation for Comparative Phase-Locked Loop Analysis," *Proc. National Electronics Conference*, Chicago, Ill., Vol. 21, Oct. 25-27, 1965.

- Long, L. L., Rutledge, R. B., and Wallace, N. D., "A Simulation Study of Phase-Locked Loop Dynamics in the Presence of Noise," Vol. 2, papers presented at the 1966 Region Six Annual Conference, Tucson, Ariz., Apr. 26-28, 1966.
- Loutit, J. A., and Story, R. F., "Flexible Phase Lock Frequency Control by Analysis Procedures," *Proc. 13th Annu. Symp. on Frequency Control*, Asbury Park, N. J., pp. 371-383, May 12-14, 1959.
- Luby, D. C., Gill, W. J., Ballard, E. J., and Spilker, S. S., *Demodulation of Angle-Modulated Telemetry Signals: Vol. 1. Advanced Demodulation Techniques*, AD 639 787; *Vol. 2. Review of Demodulation Methods*, AD 639 788, Aug. 1966.
- Ludwig, D., "A General Solution for the Shortest Acquisition Time in Type-II Phase-Lock Loops," *IEEE Trans. (Letters)*, Vol. AES-4, pp. 639-640, 1968.
- Ludwig, D., *Study, Optimization, and Comparisons of the Acquisition Characteristics of Phase-Locked Loop Systems*, N68-38155, Aztec School of Languages, Inc., Acton, Mass., Oct. 1968. (NASA translation into English from a French thesis.)
- Lyness, H. L., "Oscillator Stability in Phase-Locked Loops," *Electro-Technology*, Vol. 75, pp. 34-36, May 1965.
- Magill, D. T., "Noise Theory of Tracking Cross-Correlators," *IEEE International Convention Record*, New York, Vol. 13, Part 2, pp. 158-167, Mar. 22-26, 1965.
- Malling, L. R., "Phase-Stable Oscillators for Space Communications, Including the Relationship Between the Phase Noise, the Spectrum, the Short-Term Stability, and the Q of the Oscillator," *Proc. IRE*, Vol. 50, pp. 1656-1664, July 1962.
- Margolis, S. G., "The Response of a Phase-Locked Loop to a Sinusoid Plus Noise," *Trans. IRE*, Vol. IT-3, pp. 136-142, June 1957.
- Martin, B. D., *A Coherent Minimum-Power Lunar Probe Telemetry System*, JPL External Publication No. 610, Jet Propulsion Laboratory, Pasadena, Calif., May 1959.
- Martin, B. D., *The Mariner Planetary Communication System Design*, Technical Report 32-85, Rev. 1, Jet Propulsion Laboratory, Pasadena, Calif., May 15, 1961.
- Martin, B. D., *The Pioneer IV Lunar Probe: A minimum-Power FM/PM System Design*, Technical Report 32-215, Jet Propulsion Laboratory, Pasadena, Calif., Mar. 15, 1962.
- Martin, B. D., "Threshold Improvement in an FM Sub-Carrier System," *Trans. IRE*, Vol. SET-6, pp. 25-33, Mar. 1960; comments by J. J. Spilker in *Trans. IRE*, Vol. SET-7, p. 55, June 1961.
- Martin, J. C., *Minimum Variance Estimates of Signal Derivatives—A Problem in Instrument Landing Systems*, N71-30241, Clemson University, S. C., Dec. 1970.
- Martin, T. B., "Circuit Applications of the Field-Effect Transistor," *Semicon. Prod.*, Vol. 5, Part I, pp. 33-39, Feb. 1962; Part II, pp. 30-38, Mar. 1962.
- Mathison, R. P., "Tracking Techniques for Interplanetary Spacecraft," Paper 8-2, *Proc. 1962 Nat. Telem. Conf.*, May 1962.

- Mayfield, W. W., "A Sequence Solution to the Fokker-Planck Equation," *Proc. Hawaii International Conference on System Sciences*, pp. 474-476, Jan. 12-14, 1971.
- Maykova, T. P., "Pull-in Range of a PAFC System with Nonlinear Integrating Filter," *Telecommunications*, Vol. 23, No. 8, 1969.
- McAlcer, H. T., "A New Look at the Phase Locked Oscillator," *Proc. IRE*, Vol. 47, pp. 1137-1143, June 1959; errata: Vol. 48, p. 1771, Oct. 1960.
- McIntyre, R., *Transportable Satellite Communications Terminal X-Band Receiving Facility*, Final Technical Report, AD-618 907, Sylvania Electron. Syst., Williamsville, N. Y., June 1965.
- McKay, G. A., "An Extended Phase Detector for Phase-Locked Receivers," *Proc. IEEE Region III Convention*, Jackson, Miss., Apr. 17-19, 1967.
- McLaughlin, R. J., *A Lock-On Probability Analysis for the Initial Synchronization of Phase-Locked Loops (U)*, Technical Report No. 372, AD-433 698, Cruft Lab., Harvard University, Cambridge, Mass., Feb. 1963.
- McMaster, R. L., *Design for a Subaudio Phase-Lock, Pulse-Tracking Oscillator*, Stanford University, Calif.
- McRae, D. D., "Phase-Locked Demodulation in Telemetry Receivers," *Proc. 1958 Nat. Symp. Telem.*, Miami Beach, Fla., Sept. 1958.
- Meer, S. A., "Analysis of Phase-Locked Loop Acquisition—A Quasistationary Approach," Records of *IEEE International Convention*, New York, Vol. 14, Part 7, pp. 85-106, Mar. 21-25, 1966.
- Meers, S. A., "A Class of Wiener Filters Useful in PLL Applications," *Proc. IEEE*, Vol. 53, p. 2121, Dec. 1965.
- Meer, S. A., "A Generalized Analysis for the Acquisition Time and Pull-In Range of Phase-Locked Loops," papers presented at the *Conference on Frequency Generation and Control for Radio Systems*, London, England, May 22-24, 1967.
- Merrick, W., Rechtin, E., Stevens, R., and Victor, W., "Deep Space Communications," *IRE Trans.*, Vol. MIL-4, No. 2-3, pp. 158-162, 1960.
- Methods and Techniques Study Report, Three-Oscillator Combiner*, AD-617 144, ITT Federal Labs., Nutley, N. J., June 1965.
- Miller B. J., and Kocsis, L. L., "Phase-Lock Demodulators," *National Electronics Conference*, Oct. 1962.
- "Mod IV Planetary Radar Receiver, 2.388 Gc," in *The Deep Space Instrumentation Facility*, Space Programs Summary 37-21, Vol. III, pp. 49-61, Jet Propulsion Laboratory, Pasadena, Calif., May 31, 1963.
- Moschytz, G. S., "Miniaturized RC Filters Using Phase-Locked Loop," *Bell Syst. Tech. J.*, Vol. 44, pp. 823-870, 1965.
- Mullen, J. A., "Background Noise in Oscillators," *Proc. IRE*, Vol. 48, pp. 1467-1473, Aug. 1960.
- Murphy, J. V., "Frequency Measurement Using the Phase-Controlled Oscillator," *Proc. IEEE*, Vol. 55, No. 7, pp 1144-1153, 1967.

- Nag, B. R., "Locking Range of an Oscillator for Different Nonlinearities," *Trans. Amer. Inst. Elec. Eng.*, Part I, Vol. 79, pp. 134-136, 1960.
- Natali, F. D., "Accurate Digital Detection of Angle-Modulated Signals," Records of EASCON '68, Washington, D. C., pp. 407, 413, Sept. 9-11, 1968; also "Digital Processing Receiver Study," AD 835-767.
- Natali, F. D., and Walbesser, W. J., "Interference Rejection in a Phase-Locked Loop With Decision Feedback," Records of EASCON '68, Washington, D. C., pp. 187-192, Sept. 9-11, 1968.
- Natali, F. D., and Walbesser, W. J., "Phase-Locked-Loop Detection of Binary PSK Signals Utilizing Decision Feedback," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-5, pp. 83-90, 1969.
- Nelson, W. L., "Phase-Lock Loop Design for Coherent Angle-Error Detection in the Telstar Satellite Tracking System," *Bell Syst. Tech. J.*, Vol. 42, pp. 1941-1976, Sept. 1963.
- Nesvizhskii, Iu. B., "Pulse-Phase Locked Automatic Frequency Control," *Radiotekhnika*, Vol. 20, p. 36, Sept. 1965. Also *Telecommun. Radio Eng.*, *Radio Eng.*, Vol. 20, pp. 95-102, Sept. 1965 (translation).
- Nevarez, J. R., "Phase-Lock Plots for Injection-Locked Oscillators," *Proc. IEEE*, Vol. 56, pp. 1617-1619, 1968.
- Nielson, C. L., *Principles and Applications of Phase-Lock Detection in Phase-Coherent Systems*, Technical Note HTR 57-003, Hallamore Electronics, Corp., Anaheim, Calif., Apr. 12, 1957.
- Nikitin, N. P., "Cut-off in Tracking in a Network of Phase Automatic Frequency Control," *Automat. Remote Contr.*, Vol. 26, pp. 669-674, Apr. 1965.
- Nikitin, N. P., "Filtration of Internal Noise by a Phase Automatic Frequency Control Circuit," *Radioelektronika*, Vol. 13, pp. 764-766, June 1970 (in Russian).
- Nikitin, N. P., "Probability of Signal Acquisition by a Phase-Locked Oscillator System Operating in the Frequency Search Mode," *Radiotekhnika*, Vol. 8, pp. 696-703, Nov.-Dec. 1965 (in Russian).
- Nikitin, N. P., "Probability of Signal Hold-In in a Phase-Locked AFC Frequency Search System," *Radiotekhnika*, Vol. 8, pp. 696-703, Nov.-Dec. 1965. Also *Soviet Radio Eng.*, Vol. 8, pp. 516-520, Nov.-Dec. 1965.
- Nishimura, T., "On the A Priori Information in Sequential Estimation Problems," *IEEE Trans. Automat. Contr.*, Vol. AC-11, pp. 197-204, Apr. 1966.
- Nishimura, T., "Design of Phase-Locked Loop Systems With Correlated Noise Input," in *Supporting Research and Advanced Development*, Space Programs Summary 37-26, Vol. IV, pp. 234-240, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 30, 1964.
- Nishimura, T., "The Mean-Squared Deviation of a Phase-Locked Loop Having a Triangular S-Curve," in *Supporting Research and Advanced Development*, Space Programs Summary 37-31, Vol. IV, pp. 311-315, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 28, 1965.

- Oberst, J. F., "Generalized Phase Comparators for Improved Phase-Locked Loop Acquisition," *IEEE Trans. Commun. Technol.*, Vol. COM-19, pp. 1142-1148, Dec. 1971.
- Okkes, R. W., "Performance of Partially Coherent Binary Reception," *Proc. International Telemetry Conference*, Washington, D. C., pp. 492-504, Sept. 15-17, 1969.
- Olsen, D. P., *Equivalence of PLL Systems and a Discriminator Followed by a Nonlinear Feedback Filter*, Purdue University, Lafayette, Ind., June 1967.
- Olsen, D. P., and Lindenlaub, J. C., "A Phase Lock Loop with an Extended Linear Range Phase Detector," *Mervin J. Kelly Commun. Conf.*, University of Missouri-Rolla, Oct. 1970.
- Ongano, D., and Rocca, F., "Microwave, Nearly-Optimum Phase-Lock Demodulator," *Alta Frequenza*, Vol. 35, No. 8, pp. 845-855, 1966.
- Ordung, P. F., Gibson, J. E., and Shinn, B. J., "Closed Loop Automatic Phase Control," *Trans. AIEE*, Vol. 73, pp. 375-381, Sept. 1954.
- Osatake, T., and Fujii, A., "A Study on FM Reception by Tracking Filters," *Electron. Commun. Jap.*, Vol. 50, No. 6, pp. 100-108, 1967.
- Osatake, T., Fujii, A., and Akutagawa, T., "A Study on a Parametric Amplifier as a Tracking Filter," *Electron. Commun. Jap.*, Vol. 51B, No. 6, pp. 63-69, 1968.
- Osborne, P. W., *Threshold Analysis of Phase Locked Loops*, N70-24407, University Microfilms, Polytechnic Institute of Brooklyn, New York, 1969.
- Osborne, P. W., and Schilling, D. L., "Expected Number of Spikes of Phase Locked Loop Demodulators," *ITC Proc.*, Los Angeles, Calif., Vol. 4, 1968.
- Osborne, P. W., and Schilling, D. L., *Threshold Analysis of Phase Locked Loops*, N69-30729, Polytechnic Institute of Brooklyn, Freeport, N. Y., 1969.
- Osborne, P. W., and Schilling, D. L., "Threshold Analysis of Phase-Locked-Loop Demodulators Using Most Likely Noise," *IEEE Trans. Commun. Technol.*, Vol. COM-19, pp. 31-41, 1971.
- Osborne, P. W., and Schilling, D. L., "Threshold Performance of Phase Locked Loop Demodulators," *Proc. International Conference on Communications*, Philadelphia, Pa., June 12-14, 1968.
- O'Sullivan, M. R., "Tracking Systems Employing the Delay-Lock Discriminator," *Trans. IRE*, Vol. SET-8, pp. 1-7, Mar. 1962.
- Palka, F. M., "Measured FM Noise Reduction by Injection Phase Locking," *Proc. IEEE*, Vol. 58, pp. 155-157, 1970.
- Pasternak, G., and Whalin, R. L., "Analysis and Synthesis of a Digital Phase-Locked Loop for FM Demodulation," *Bell Syst. Tech. J.*, Vol. 47, No. 10, pp. 2207-2239, Dec. 1968.
- Pearce, J. L. R., *Optimum Reception of Digital FM Signals*, Queens University, Kingston, Ontario.

- Pedersen, B. O., "Phase-Sensitive Detection with Multiple Frequencies," *Trans. IRE*, Vol. I-9, pp. 349-354, Dec. 1960.
- Pervachev, S. V., "Lock In Range of Phase Synchronized A.F.C.," *Radio Eng. Electron. Phys.*, Vol. 8, No. 2, pp. 287-290, Feb. 1963.
- Peter, M., and Strandberg, M. W. P., "Phase Stabilization of Microwave Oscillators," *Proc. IRE*, Vol. 43, pp. 869-873, July 1955.
- Petrishchev, V. I., "Synthesis of a Time-Optimal Phase-Locked AFC System," *Radiotekhnika*, Vol. 26, pp. 64-71, Feb. 1971 (in Russian).
- "A Phase-Locked Loop with Sideband Rejecting Properties," and "Sideband Lock Investigation," in *The Deep Space Instrumentation Facility*, Space Programs Summary 37-21, Vol. III, pp. 76-83, Jet Propulsion Laboratory, Pasadena, Calif., May 31, 1963.
- Phase-Locked Loop Study*, Phase I (June 15, 1961) and Phase II (Dec. 15, 1961) of Project 2-520-1202, Motorola, Inc., Military Electronics Division, Scottsdale, Ariz.
- Pierce, J. A., "Intercontinental Frequency Comparison by VLF Radio Transmission," *Proc. IRE*, Vol. 45, pp. 794-803, June 1957.
- Poynter, R. L., and Steffensen, G. R., "Tunable High Stability Microwave Oscillator," *Rev. Sci. Inst.*, Vol. 34, pp. 77-82, Jan. 1963.
- Preston, G. W., "Basic Theory of Locked Oscillators in Tracking FM Signals," *Trans. IRE*, Vol. SET-5, pp. 30-32, Mar. 1959.
- Preston, G. W., and Tellier, J. C., "The Lock-In Performance of an AFC Circuit," *Proc. IRE*, Vol. 41, pp. 249-251, 1953.
- Proni, E., "FM Demodulator Employing an Injection Locked Oscillator," *Alta Frequenza*, Vol. 38, pp. 95-103, 1969.
- Protonotarios, E. N., "The Effect of Phase Jitter on the Performance of a First-Order Phase-Locked Loop," *IEEE Trans. Commun. Technol.*, Vol. COM-18, No. 1, pp. 74-76, 1970.
- Protonotarios, E. N., "Pull-In Performance of a Piecewise Linear Phase-Locked Loop," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-5, No. 3, pp. 376-386, 1969.
- Pullen, K. A., *The Dynamic Characteristics of Phase-Lock Receivers*, Report No. 1093, Ballistic Research Laboratories, Aberdeen Proving Ground, Md., Jan. 1960.
- Pullen, K. A., "A Theory of Frequency Tracking for Narrowband Communications," *6th Nat. Commun. Symp.*, Utica, N. Y., Oct. 1960, pp. 83-89.
- Radionov, Ia. G., "Optimization of Transfer Function and Noise Band of a Linear Model of a Tracking Filter in the Presence of Fluctuation Noise," *Radio Eng. Electron. Phys.*, Vol. 15, pp. 1716-1719.
- Rajasekaran, P. K., and Srinath, M. D., "Switchless Control Strategies for Minimum Time Frequency Transitions in Phase-Locked Loops," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-5, pp. 984-988, 1969.

- Rao, K. R., and Stewart, T. L., "Optimum Performance of a Hybrid Phase-Locked Loop," *Proc. 4th. Hawaii International Conference on System Sciences*, University of Hawaii, Honolulu, pp. 672-674, Jan. 12-14, 1971.
- Real, R. R., "Direct Frequency Modulation of Crystal Controlled Transistor Oscillators," *IEEE Trans. Commun. Syst.*, Vol. CS-10, p. 459, Dec. 1962.
- Rechtin, E., *The Design of Optimum Linear Systems*, JPL External Publication No. 204, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 1953.
- Rechtin, E., *Design of Phase Lock Oscillator Circuits*, Section Report No. 8-566, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 7, 1957.
- Rey, T. J., "Automatic Phase Control: Theory and Design," *Proc. IRE*, Vol. 48, pp. 1760-1771, Oct. 1960. Corrections in *Proc. IRE*, p. 590, Mar. 1961.
- Rey, T. J., *Effects of the Filter in Oscillator Synchronization*, Technical Report 181, Lincoln Lab., M.I.T., Lexington, Mass., May 1958.
- Rey, T. J., "Further on the Phase-Locked Loop in the Presence of Noise," *Proc. IEEE*, Vol. 53, pp. 494-495, 1965.
- Rey, T. J., "Stability of an APC System for Frequency Division," *Proc. IEEE (Letters)*, Vol. 54, pp. 73-74, Jan. 1966.
- Rey, T. J., Bozzoni, E., and Mengali, U., "Comments on Comparison between the Oscillating Limiter and the First-Order Phase-Locked Loop," *Proc. IEEE (Letters)*, Vol. 57, No. 4, p. 726, 1969.
- "RF Voltage Controlled Oscillator Developments," in *Deep Space Instrumentation Facility*, Space Programs Summary 37-15, Vol. III, pp. 34-36, Jet Propulsion Laboratory, Pasadena, Calif., May 31, 1962.
- Rhee, M. Y., "New Discussion on Noise and Non-linear Effects in Telemetry Links," *Proc. National Electronics Conference*, Vol. 25, pp. 844-848, Dec. 8-10, 1969.
- Rhee, M. Y., Lindauer, C. M., and Gohain, P. K., "State Modeling of Phase-Locked Loops with Random Modulation and Additive Noise," *Mervin J. Kelly Commun. Conf.*, University of Missouri-Rolla, Oct. 1970.
- Rice, J. E., Jr., *Phase-Locked Tracking Filter*, Sylvania Electric Products, Inc., Mountain View, Calif., June 25, 1963.
- Richman, D., "APC Color Sync for NTSC Color Television," *IRE Conv. Rec.*, Part 4, 1953.
- Richman, D., "Color-Carrier Reference Phase Synchronization Accuracy in NTSC Color Television," *Proc. IRE*, Vol. 43, pp. 106-133, Jan. 1954.
- Richman, D., "DC Quadricorrelator: A Two Mode Sync System," *Proc. IRE*, Vol. 42, pp. 288-299, Jan. 1954.
- Richter, H., Stevens, R., and Sampson, W. F., *Microlock: A Minimum Weight Instrumentation System for a Satellite*, JPL External Publication No. 376, Jet Propulsion Laboratory, Pasadena, Calif.
- Ridgway, R., "A Method of Calculating Phase-Lock Threshold," *Proc. IEEE (Letters)*, Vol. 54, pp. 2024-2025, 1966.

- Ridgway, R. I., and Carter, J. E., "More Comments on the Phase-Locked Loop Threshold," *Proc. IEEE (Letters)*, Vol. 55, No. 8, pp. 1531-1533, 1967.
- Riedel, E. G., Jr., *The Effect of Frequency Tracking, the Use of a Phase Lock Loop, and Predicted Tracking on Receiver Sensitivity*, AD-286920, Air Force Institute of Technology, Wright-Patterson AFB, Ohio, Aug. 1962.
- Rihaczek, A. W., *Dynamic Bandwidth of Phase-Modulated Signals*, Aerospace Corp., El Segundo, Calif., Aug.-Oct. 1967.
- Roberts, C. A., and Vitenas, A., *A Study of the Synchronization of Two Oscillators*, N69-11063, Harry Diamond Laboratories, Washington, D. C., June 1968.
- Robinson, E. M., *Acquisition Capabilities of Phase-Locked Oscillators in the Presence of Noise*, TTS No. R60DSD11, General Electric Co., Syracuse, N. Y., Sept. 1960.
- Robinson, E. M., and Woods, C. R., *Acquisition Capabilities of Phase-Locked Oscillators in the Presence of Noise*, Tech. Inform. Ser. No. R60 DSD 11, General Electric Co., Sept. 15, 1960.
- Robinson, L. M., "TANLOCK: A Phase-Lock Loop of Extended Tracking Capability," *Proc. 1962 Convention on Military Electronics*, Los Angeles, Calif., Feb. 7-9, 1962.
- Robson, P. G., "The Pull-In Range of a Phase-Locked Loop," papers presented at the *Conference on Frequency Generation and Control for Radio Systems*, London, England, May 22-24, 1967.
- Rocca, F., "Some Properties of Optimum Unconditionally Stable Phase-Lock Demodulators," *Alta Frequenza*, Vol. 36, pp. 424-429, May 1967.
- Roland, W. F., et al., *Threshold Criterion for Phase-Locked Loop Design*, Technical Memo 59, Philco Western Development Laboratories, May 1963.
- Rowbotham, J. R., *Phase-Locked Loop Study*, N68-80467, Final Report, Motorola, Inc., Scottsdale, Ariz., June 15, 1961.
- Rue, A. K., and Lux, P. A., "Transient Analysis of a Phase Locked Loop Discriminator," *Trans. IRE*, Vol. SET-7, pp. 105-111, Dec. 1961.
- Runyan, R. A., "Factors Affecting Choice of Loop Filters in Phase-Locked Loop Discriminators," Paper 9-1, *Proc. Nat. Symp. on Space Electron. and Telem.*, 1959.
- Runyan, R. A., "Technique in the Application of Phase Lock Demodulators to Data Processing," Paper 9-3, *Proc. Nat. Telem. Conf.*, 1962.
- Ruthroff, C. L., "Injection-Locked-Oscillator FM Receiver Analysis," *Bell Syst. Tech. J.*, Vol. 47, pp. 1653-1661, 1968.
- Safonov, V. M., "Influence of the Shape of the Sawtooth Characteristic of a Phase Detector on the Locking Range of a Phase-Locked Oscillator," *Radio-tekhnika*, Vol. 24, pp. 76-80, June 1969.
- Sage, G. F., "Performance of Multilevel PCM," *IEEE Trans. Aerosp. Electron. Syst.*, Supplement, Vol. AES-2, pp. 353-361, July 1966.

- Sakarov, S., "Frequency-Controlled Oscillators," *Communications*, Vol. 19, No. 50, pp. 7-9, 1939.
- Samoilenko, I. I., "The Reliability of the Synchronization of an Auto Generator in the Presence of Modulated Oscillations," *Radio Eng. USSR*, Vol. 15, No. 7, pp. 61-68, 1960.
- Sampson, W. F., *Comparative Noise Performance of Phase-Lock and Pulse-Counting Discriminators*, Technical Note HTR 58-007, Hallamore Electronics Corp., Anaheim, Calif., Feb. 28, 1958.
- Sampson, W. F., and Ruegg, F. A., "Phase-Lock in Space Communications," Paper 1-3, *Proc. Nat. Symp. Space Electron. and Telem.*, Sept. 1959.
- Sanders, R. W., "Digilock Telemetry System," presented at *Nat. Symp. Space Electron. Telemetry*, San Francisco, Calif., Sept. 1959.
- Sanger, D. K., *Digital Demodulation with Data Subcarrier Tracking*, Technical Report 32-1314, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 1, 1968.
- Sanger, D., and Tausworthe, R. C., "Digital Communication and Tracking: An Experimental Study of the First-Slip Statistics of the Second-Order Phase-Locked Loop," in *The Deep Space Network*; Space Programs Summary 37-43, Vol. III, pp. 76-80, Jet Propulsion Laboratory, Pasadena, Calif., Jan. 31, 1967.
- Sann, K. H., "Phase Stability of Oscillators," *Proc. IRE*, Vol. 49, pp. 527-528, Feb. 1961.
- Sanneman, R. W., and Gupta, S. C., "Optimum Strategies for Minimum-Time Frequency Transitions in Phase-Locked Loops," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-2, pp. 570-581, 1966.
- Sanneman, R. W., and Rowbotham, J. R., "Random Characteristics of the Type II Phase-Locked Loop," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-3, pp. 604-612, July 1967.
- Sanneman, R. W., and Rowbotham, J. R., "Unlock Characteristics of the Optimum Type II Phase-Locked Loop," *IEEE Trans. Aerosp. Navig. Electron.*, Vol. ANE-11, pp. 15-24, Mar. 1964.
- Sapp, D. H., *A Synchronous Detection System Utilizing a New Method of Frequency and Phase Control*, MS thesis, University of Pennsylvania, Philadelphia, Pa., June 1960.
- Sassler, M., "A Phase-Locked Demodulator for Multichannel Telephone Traffic from Satellites," *Proc. Nat. Electron. Conf.*, Vol. 20, pp. 481-485, 1964.
- Sassler, M., and Surelian, R., "Communication Receiver for Satellite Ground Station," *Elec. Commun.*, Vol. 39, No. 1, pp. 89-97, 1964.
- Schanne, J., and Hannan, W., "Use of a Phase-Locked Oscillator in PSK Demodulators," *RCA Eng.*, Vol. 6, pp. 27-28, 1961.
- Schilling, D. L., "Intermodulation Distortion of a Phase Locked Loop Demodulator," *IEEE Trans. Commun. Technol.*, Vol. COM-15, pp. 222-228, Apr. 1967.
- Schilling, D. L., *Optimal Space Communications Techniques*, Status Report, City College of New York, New York, Mar. 16-June 15, 1970.
- Schilling, D. L., *Optimal Space Communications Techniques*, Status Report, City College of New York, New York, Sept. 15-Dec. 15, 1970.

- Schilling, D. L., "The Response of an Automatic Phase Control System to an FM Signal in the Presence of Gaussian Noise," *IEEE Int. Conv. Rec.*, Part 8, pp. 242-246, Mar. 1963.
- Schilling, D. L., "The Response of an Automatic Phase Control System to FM Signals and Noise," *Proc. IEEE*, Vol. 51, pp. 1306-1315, Oct. 1963.
- Schilling, D. L., *The Response of an Automatic Phase Control System to FM Signals and Noise*, Report PIBMRI-1040-62, N63-12322, Polytechnic Institute of Brooklyn, New York, June 1962.
- Schilling, D., et al., "Digital Phase-Locked Loop FM Demodulator," presented at the *IEEE Int. Conf. Communications*, Montreal, Que., Canada, 1971.
- Schilling, D. L., Abrams, B. S., Oberst, J. F., and Berkoff, M., "Phase Locked Loop Threshold," *Proc. IEEE (Letters)*, Vol. 53, p. 1673, 1965.
- Schilling, D. L., and Billig, J., *A Comparison of the Threshold Performance of the Frequency Demodulator Using Feedback and the Phase Locked Loop*, Report No. PIB MRI-1207-64, Polytechnic Institute of Brooklyn, New York, Feb. 28, 1964.
- Schilling, D. L., and Billig, J., "On the Threshold Extension Capability of the PLL and the FDMFB," *Proc. IEEE*, Vol. 52, pp. 621-622, 1964.
- Schilling, D. L., Billig, J., and Kermisch, D., "Error Rates in FSK Using the Phase Locked Loop Demodulator," *1st IEEE Annu. Commun. Conv.*, Boulder, Colo., June 1965.
- Schilling, D. L., and Schwartz, M., "The Response of an Automatic Phase Control System to FM Signals and Noise," *IRE Int. Conv. Rec.*, Part 8, pp. 111-121, Mar. 1962.
- Schilling, D. L., and Smith, B. M., "Comments on Phase-Locked Loop Threshold," *Proc. IEEE (Letters)*, Vol. 55, pp. 82-83, 1967.
- Schlesinger, K., "Lock Oscillator for Television Synchronization," *Electronics*, Vol. 22, pp. 112-117, Jan. 1949.
- Schmueckle, W., *A Contribution for Optimization Demodulation of Disturbed Frequency Modulation Signals*, Technische Hochschule, Hannover, West Germany, 1967 (in German).
- Schmueckle, W., "Optimum Demodulation of Disturbed Frequency-Modulated Signals," *Nachrichtentechnische Zeitschrift*, Vol. 21, pp. 464-470, Aug. 1968.
- Schrader, J. H., "A Phase-Lock Receiver for the Arraying of Independently Directed Antennas," *IEEE Trans. Anten. Prop.*, Vol. AP-12, pp. 155-160, 1964.
- Schuchman, L., *Acquisition Time in a First Order Phase Lock Loop*, N70-35562, Bellcomm, Inc., Washington, D. C., July 10, 1970.
- Schuchman, L., *Characterizing the Behavior of Phase Lock Loops*, N70-26998, Bellcomm, Inc., Washington, D. C., Feb. 20, 1970.
- Schuchman, L., "Time to Cycle Slip in First and Second Order Phase Lock Loops," *Proc. International Conference on Communications*, San Francisco, Calif., pp. 34-1 to 34-9, June 8-10, 1970.

- Schulman, R. J., and Unkauf, M. G., "Experimental Signal/Noise-Ratio Comparison of the Second-Order Phase-Locked Loop and the Second-Order Frequency-Locked Loop," *Electronics Letters*, Vol. 4, pp. 585-586, 1968.
- Schwartz, L. S., "Phase-Lock for Aerospace Communications Receivers," *Space/Aeronautics*, pp. 71-75, Feb. 1962.
- Schwartz, M., *Maximum A Posteriori Demodulation of Analogue-Type Signals Through Random Fading Media*, Polytechnic Institute of Brooklyn, New York, 1964.
- Schwartz, M., Bennett, R. W., and Stein, S., *Communication Systems and Techniques*, McGraw-Hill Book Co., Inc., New York, 1966.
- Seay, T. S., *Short-Term Oscillator Stability Specifications for Phase-Locked Loops*, N68-26668, Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Apr. 29, 1968.
- Segrue, D. F., *The First Order Phase Locked Loop*, MS Project Report, Polytechnic Institute of Brooklyn, New York, June 1970.
- Selin, I., and Tuteur, F., "Synchronization of Coherent Detectors," *IEEE Trans. Commun. Syst.*, Vol. 11, No. 1, pp. 100-109, Mar. 1963.
- Sepe, R. B., "Utilizing a Digital Control Loop," *Comput. Des.*, pp. 54-63, May 1968.
- Shaft, P., *Optimum Design of the Nonlinearity in Signal Tracking Loops*, Stanford Research Institute, Menlo Park, Calif., May 1968.
- Shaft, P. D., and Dorf, R. C., "Maximization of the Mean Time to Loss of Lock," *Proc. First Asilomar Conference on Circuits and Systems*, Pacific Grove, Calif., pp. 387-396, Nov. 1-3, 1967, published by Western Periodicals Co.
- Shaft, P. D., and Dorf, R. C., "Minimization of Communication-Signal Acquisition Time in Tracking-Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 495-499, June 1968.
- Shaft, P. D., and Dorf, R. C., "Reduction of Communications Signal Acquisition Time Through Nonlinear Design," *Proc. National Electronics Conference*, Vol. 23, pp. 588-592, National Electronics Conference, Inc., Oct. 1967.
- Shakhgildian, V. V., "Determination of Capture Band of a Phase Lock AFC System When the Reference Signal Is Phase Modulated," *Radio Eng. Electron. Phys.*, Vol. 11, No. 10, 1965.
- Shakhgildian, V. V., "Pull-in Range of a PAFC System with Inertia in the Presence of Fluctuating Interference," *Telecommun. Radio Eng.*, Vol. 21, p. 73, Feb. 1967.
- Shakhgildian, V. V., "Statistical Dynamics of a Phase-Locked Automatic Frequency Control System," *Radiotekhnika*, Vol. 25, pp. 66-70, May 1970 (in Russian).
- Shakhgildian, V. V., and Liakhovkin, A. A., "Filtering of a Monochromatic Signal by a Phase-Locked Oscillator," *Elektrosvyaz*, Vol. 18, pp. 11-18, 1964.
- Shakhgildian, V. V., and Lyakhovkin, A. H., *Faxovaia Avlopodstoika Chasttoly*, Moscow, 1966.
- Shakhtarin, B. I., "Certain Characteristics of a Nonlinear Phase Synchronization System," *Radiotekhnika*, Vol. 26, pp. 96-99, Apr. 1971.

- Shakhtarin, B. I., "A Critical Case in Phase-Lock Control," pp. 635-637, and "Desynchronization in a Phase AFC System," pp. 641-644, *Radio Eng. Electron. Phys.*, Vol. 13, No. 4, 1968.
- Shakhtarin, B. I., "Filtering Ability of a Phase-Locked AFC System," *Telecommun. Radio Eng. USSR*, Part 1, Vol. 20, pp. 20-25, 1966.
- Shakhtarin, B. I., "Filtering Capacity of a Phase-Locked AFC System," *Elektrosviaz'*, Vol. 20, Apr. 1966. Also *Telecommun. Radio Eng., Part I—Telecommun.*, Vol. 20, pp. 20-25, Apr. 1966.
- Shakhtarin, B. I., and Shchepkin, Yu. N., "Experimental Study of the Action of Fluctuation Noise on a Phase-Locked AFC System," *Telecommun. Radio Eng. USSR*, Part 1, Vol. 20, pp. 15-19, 1966.
- Shakhtarin, B. I., and Shishkin, V. I., "Signal Capture in a Phase-Locked Oscillator During a Frequency Search," *Radiotekhnika*, Vol. 25, pp. 74-79, Jan. 1970.
- Shakhtarin, B. I., and Shishkin, V. I., "Signal Locking by a Phase-Locked AFC System in the Frequency-Search Mode," *Telecommun. Radio Eng., Part II—Radio Eng.*, Vol. 25, pp. 115-118, Jan. 1970.
- Sherman, R. J., "Quadri-Phase-Shift-Keyed Signal Detection with Noisy Reference Signal," Records of *EASCON '69*, Washington, D. C., pp. 45-52, Oct. 27-29, 1969.
- Shreve, R., "Techniques for Analyzing a Phase-Lock Communication System's Performance," *Trans. Saturn V/Apollo and Beyond*, National Symposium, Huntsville, Ala., Vol. 4, June 11-14, 1967.
- Simon, M. K., "On the Equivalence in Performance of Several Phase-Locked Loop Configurations," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 449-452, 1970.
- Simon, M. K., "Nonlinear Analysis of an Absolute Value Type of an Early-Late Gate Bit Synchronizer," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 589-596, 1970.
- Sizov, V. P., "Phase Lock Automatic Frequency Control System with a Phase Shifter in the Feedback Circuit," *Telecommun. Radio Eng.*, No. 1, p. 90, Jan. 1967.
- Sizov, V. P., "Stationary Regimes of Phase-Locked Automatic Frequency Control," *Elektrosviaz'*, Vol. 22, pp. 63-67, 1968.
- Smith, B. M., "Phase-Locked Loop Threshold," *Proc. IEEE (Letters)*, Vol. 54, pp. 810-811, 1966; comments: Vol. 55, pp. 82-83, 1967.
- Smith, B. M., "The Phase-Lock Loop with Filter: Frequency of Slipping Cycles," *Proc. IEEE*, Vol. 54, pp. 296-297, Feb. 1966.
- Smith, B. M., "A Semi-Empirical Approach to the PLL Threshold," *IEEE Trans. Aerosp. Electron. Syst.*, Vol. AES-2, pp. 463-468, July 1966.
- Smith, B. M., *Some Aspects of Phase-Locked Loop Behavior in the Presence of Noise*, Ph.D. thesis, University of Adelaide, Australia, May 1968.
- Smith, L. J., *Use of Phase-Lock Loop Control for Driving Ultrasonic Transducers*, N66-33455, NASA Lewis Research Center, Cleveland, Ohio, Aug. 1966.

- Smith, P. G., *A Study of the Effects of Interference on Narrowband Phase Lock Loops*, Final Report, Research Triangle Institute, Durham, N. C., Oct. 15, 1965.
- Smith, W. L., "Miniature Transistorized Crystal-Controlled Precision Oscillators," *Trans. IRE*, Vol. I-9, pp. 141-148, Sept. 1960.
- Spilker, J. J., Jr., "Delay-Lock Tracking of Binary Signals," *IEEE Trans. Space Electron. Telem.*, Vol. SET-9, pp. 1-12, Mar. 1963.
- Spilker, J. J., Jr., "Threshold Comparison of Phase-Lock, Frequency-Lock and Maximum-Likelihood Types of FM Discriminators," presented at the *IRE Wescon Conference*, San Francisco, Calif., Aug. 22-25, 1961.
- Spilker, J. J., Jr., and Magill, D. T., "The Delay-Lock Discriminator—An Optimum Tracking Device," *Proc. IRE*, Vol. 49, pp. 1403-1416, Sept. 1961.
- Splitt, F. G., "Design and Analysis of a Linear PLL of Wide Dynamic Range," *IEEE Trans. Commun. Technol.*, Vol. COM-14, pp. 432-440, 1966.
- Springett, J. C., "Telemetry and Command Techniques for Planetary Spacecraft," in *Advances in Communication Systems Theory and Applications*, Vol. I, pp. 77-128, edited by A. V. Balakrishnan, Academic Press, Inc., New York, 1965.
- Stein, J. J., and Weber, C. L., "Cascaded Phase Locked Loops," *Proc. NEC 68*, National Electronics Conference, Chicago, Ill., pp. 181-186, 1968.
- Stephenson, J. M., *Analysis of Phase Locked Loops*, Western Development Laboratories WDLTR 1599, AD-448 450, Philco Corp., Palo Alto, Calif., Nov. 1961.
- Stevens, R., and Brockman, M. H., *Design and Performance of Deep Space Tracking and Telemetry System*, JPL External Publication No. 629, Jet Propulsion Laboratory, Pasadena, Calif., May 1959.
- Stewart, T. L., *Analysis of a Hybrid Phase-Lock Loop*, N70-28432, NASA Electronics Research Center, Cambridge, Mass., June 1970.
- Stewart, T. L., "Analysis of a Hybrid Phase-Locked Loop for Improved Phase Estimation," *Proc. 13th Midwest Symposium on Circuit Theory*, May 7-8, 1970.
- Stewart, T. L., *Analysis of a Hybrid Phase-Lock Loop*, N70-28432, NASA Electronics Research Center, Cambridge, Mass., June 1970.
- Stiffler, J. J., "Coding and Synchronization—The Signal Design Problem," in *Advances in Communication Systems—Theory and Applications*, Vol. 3, pp. 117-148, 1968.
- Stiffler, J. J., "Communication Systems Development: On the Optimality of the Square-Wave Correlation Function for the First-Order Loop," in *Supporting Research and Advanced Development*, Space Programs Summary 37-43, Vol. IV, pp. 321-323, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 28, 1967.
- Stiffler, J. J., "On the Performance of a Class of PCM Bit Synchronizers," Records of NTC 69, *National Telemetry Conference*, Washington, D. C., pp. 67-70, Apr. 22-24, 1969.
- Stiffler, J. J., "Phase-Locked Synchronization With Sinusoidal Signals," in *Supporting Research and Advanced Development*, Space Programs Summary 37-27, Vol. IV, pp. 208-212, Jet Propulsion Laboratory, Pasadena, Calif., June 30, 1964.
- Stiffler, J. J., "On the Selection of Signals for Phase-Locked Loops," Digest of papers, *Int. Conf. Commun.*, Minneapolis, Minn., June 1967.

- Stiffler, J. J., "On the Selection of Signals for Phase-Locked Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 239-244, 1968.
- Stiffler, J. J., "The Squaring Loop Technique for Binary PSK Synchronization," in *Supporting Research and Advanced Development*, Space Programs Summary 37-26, Vol. IV, pp. 240-246, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 30, 1964.
- Stiffler, J. J., *Theory of Synchronous Communications*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1970.
- Strandberg, M. W. P., "Noise Spectrum of Phase-Locked Oscillators," *Proc. IRE*, Vol. 48, pp. 1168-1169, June 1960.
- Strandberg, P. M., "Phase Stabilization of Microwave Oscillators," *Proc. IRE*, Vol. 43, pp. 869-873, 1955.
- Stratemeyer, H. P., "A Low-Noise Phase Locked-Oscillator Multiplier," *Interim Proc. Symp. on Definition and Measurement of Short-Term Frequency Stability*, NASA Goddard Space Flight Center, Greenbelt, Md., Part III, pp. 121-136, Dec. 1964.
- Stratonovich, R. L., "Oscillator Synchronization in the Presence of Noise," *Radio Eng. Electron.*, Vol. 3, No. 4, pp. 54-68, 1958.
- Strauch, R. G., "Phase Locking Millimeter Sources for Frequency Control," *Frequency*, Prototype Issue, pp. 16-18, 1962.
- Strom, T., *Approximation of the Probability Density Function of a Phase-Locked Loop*, Technical Report No. 45, Royal Institute of Technology, Stockholm 70, Sweden, July 1971.
- "Strong Signal Sideband Discriminator," in *The Deep Space Instrumentation Facility*, Space Programs Summary 37-22, Vol. III, pp. 38-43, Jet Propulsion Laboratory, Pasadena, Calif., July 31, 1963.
- Study Report for the Development of Techniques to Automatically Acquire the Carrier of AM or PM Signals*, N67-35322, Electrac, Inc., Anaheim, Calif., June 15, 1967.
- Summer, H. M., *An Analysis of the Effects of Differential Phase Feedback on a Type 2 Feedback Control System As Applied to Phase-Lock Receivers*, Technical Report No. 8, N66-85762, Elect. Eng. Dept., Auburn Res. Foundation, Auburn, Ala., June 15, 1965.
- Suter, C. F., Jr., *Performance of a Combination Phase and Frequency Lock System*, Naval Ordnance Laboratory, White Oak, Md., Feb. 3, 1967.
- Svoboda, D. E., *Phase and Amplitude Control for Arrays with Increased Directivity*, AD-461 633, Ohio State University Research Foundation, Columbus, Ohio, Mar. 1965.
- Svoboda, D. E., *A Phase-Locked Receiving Array for High-Frequency Communications Use*, AD-464 374, Antenna Lab., Ohio State University Research Foundation, Columbus, Ohio, Aug. 1963.
- Svoboda, D. E., "A Phase-Locked Receiving Array for High-Frequency Communications Use," *IEEE Trans. Anten. Prop.*, Vol. AP-12, pp. 207-215, 1964.

Sykes, R. A., Smith, W. L., and Spencer, W. J., "Performance of Precision Quartz-Crystal Controlled Frequency Generators," *Trans. IRE*, Vol. I-11, pp. 243-247, Dec. 1962.

Tausworthe, R. C., "Asymptotic Formula for Mean Cycle-Slip Time of Second-Order Phase Locked Loops with Frequency Offset," *IEEE Trans. Commun. Technol.*, to be published.

Tausworthe, R. C., "Communications Systems Development: Acquisition and False-Lock Behavior of Phase-Locked Loops With Noisy Inputs," in *Supporting Research and Advanced Development*, Space Programs Summary 37-46, Vol. IV, pp. 226-234, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 31, 1967.

Tausworthe, R. C., "Communication Systems Development: Cycle Slipping in Phase-Locked Loops," in *Supporting Research and Advanced Development*, Space Programs Summary 37-42, Vol. IV, pp. 200-205, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1966.

Tausworthe, R. C., "Communications Systems Development: Efficiency of Noisy Reference Detection," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 195-201, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.

Tausworthe, R. C., "Cycle Slipping in Phase-Locked Loops," *IEEE Trans. Commun. Technol.*, Vol. COM-15, pp. 417-421, June 1967.

Tausworthe, R. C., "Digital Communication and Tracking: Limit-Cycles in Passive-Filter Phase-Locked Loops," in *Supporting Research and Advanced Development*, Space Programs Summary 37-41, Vol. IV, pp. 268-270, Jet Propulsion Laboratory, Pasadena, Calif., Oct. 31, 1966.

Tausworthe, R. C., "Information Processing: Limiters in Phase-Locked Loops: A Correction to Previous Theory," in *Supporting Research and Advanced Development*, Space Programs Summary 37-54, Vol. III, pp. 201-204, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.

Tausworthe, R. C., "A Method for Calculating Phase-Locked Loop Performance Near Threshold," *Proc. 1966 National Telemetry Conference*, Boston, Mass., May 10-12, 1966.

Tausworthe, R. C., "Minimizing VCO Noise Effects in Phase-Locked Loops," in *Supporting Research and Advanced Development*, Space Programs Summary 37-33, Vol. IV, pp. 287-289, Jet Propulsion Laboratory, Pasadena, Calif., June 30, 1965.

Tausworthe, R. C., "New Calculation of Phase-Locked Loop Performance," in *Supporting Research and Advanced Development*, Space Programs Summary 37-31, Vol. IV, pp. 292-300, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 28, 1965.

Tausworthe, R. C., "Simplified Formula for Mean Cycle-Slip Time of Phase-Locked Loops with Steady-State Phase Error," *IEEE Trans. Commun. Technol.*, Vol. COM-20, No. 3, pp. 331-337, June 1972.

Tausworthe, R. C., *Theory and Practical Design of Phase-Locked Receivers: Volume I*, Technical Report 32-819, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 15, 1966.

- Taylor, R. E., *Automatic Acquisition System for Phase-Lock Loop*, N69-21543, NASA Goddard Space Flight Center, Greenbelt, Md., Jan. 7, 1969.
- Terent, C. V. P., and Shakhgildian, V. V., "Obtaining Highly Stable Variable Frequency by the Use of Automatic Phase Adjustment," *Telecommun. USSR (London)*, pp. 1194-1202, 1960.
- Theoretical and Experimental Studies of Sub-Optimal Second and Third Generation Self-Adaptive Binary*, Semiannual Report, Purdue University, Lafayette, Ind., Jan. 1-June 30, 1969.
- Thirup, G., "The Application of Phase-Locking Techniques to the Design of Apparatus for Measuring Complex Transfer Functions," *Brit. IRE*, pp. 387-396, May 1960.
- Thomas, C. M., "Optimization of Phase-Lock Demodulator for Single-Channel Voice," *Proc. Int. Commun. Conf.*, Philadelphia, Pa., June 1966. Also *Micro-wave J.*, Vol. 10, No. 7, pp. 43-47, 1967.
- Thomas, C. M., "Study Charts Phase-Locked Demodulator Distortion in TV, Multichannel Telephony," *Commun. Designer's Digest*, pp. 34-38, 1969.
- Thomas, E. F., *Investigation and Analog Simulation of the Type Two and Type Three Phase-Lock Loop*, AD-295096, Air Force Institute of Technology, Wright-Patterson AFB, Ohio, Dec. 1962.
- Thomson, D. N., "Performance of the Self Cohered Detector," *5th Annu. Radar Symp.*, Willow Run Lab., University of Michigan, pp. 85-91, Jan. 1959.
- Threshold Extension in FM Receivers*, X70-70119, LTV Electrosystems, Inc., Dallas, Tex., Feb. 1968.
- Tikhonov, V. I., "Effect of Fluctuations on the Operating Accuracy of Synchronization Equipment," *Soviet Physics—Uspekhi*, Vol. 7, pp. 574-591, Jan.-Feb. 1965.
- Tikhonov, V. I., "Effect of Fluctuations Upon the Operational Precision of Synchronizing Systems," *Uspekhi Fizicheskikh Nauk*, Vol. 83, pp. 665-694, Aug. 1964.
- Tikhonov, V. I., "The Effect of Noise on Phase-Lock Oscillation Operation," *Automatika i Telemekhanika*, Vol. 22, No. 9, 1959.
- Tikhonov, V. I., "The Operation of Phase Automatic Frequency Control in the Presence of Noise," *Autom. Remote Contr.*, Vol. 21, No. 3, pp. 209-214, 1960.
- Tikhonov, V. I., "Phase-Lock Automatic Frequency Control Application in the Presence of Noise," *Automatika i Telemekhanika*, Vol. 23, No. 3, 1960.
- Tucker, D., "Carrier Frequency Synchronization," *Post Office Elec. Eng.*, Vol. 33, pp. 75-81, 1940.
- Tucker, D. G., "The Synchronization of Oscillators," *Electron. Eng.*, Vol. 16, pp. 26-30, June 1943.
- Urhan, J. J., "Characteristics of a Suboptimum Phase-Lock Demodulator," *Proc. 6th Annual Allerton Conference on Circuit and System Theory*, Monticello, Ill., Oct. 2-4, 1968.
- Urhan, J. J., Jr., "Cycle-Slipping Effects on the Output Signal of a Phase-Locked Demodulator," *Proc. IEEE (Letters)*, Vol. 56, No. 1, pp. 80-81, 1968.

- Urhan, J. J., *Cycle Slipping and FM Signal Distortion for a Class of Phase Lock Loops*, Notre Dame University, Ind.
- Urhan, J. J., *Threshold Study of Phase Lock Loop Systems*, University Microfilms, Purdue University, Lafayette, Ind.
- Urhan, J. J., and Lindenlaub, J. C., "Effects of a Class of Phase Comparators on the Threshold and Lock Range of Phase Lock Loop Systems," *Proc. 3rd Int. Conf. Commun.*, Minneapolis, Minn., June 1967.
- Urhan, J. J., Jr., and Lindenlaub, J. C., "Experimental Results for Phase-Lock Loop Systems Having a Modified n th Order-Tanlock Phase Detector," *IEEE Trans. Commun. Technol.*, Vol. COM-16, No. 6, Dec. 1968.
- Uyeda, H., "Accuracy of Frequency Comparison," *J. Radio Res. Lab.*, Vol. 10, pp. 335-345, 1963.
- Vanbierkom, R., et al., *Advanced Digital Receiver Design Study*, Technical Report TR-66-602, AD 805 009, Rome Air Development Center, Griffiss Air Force Base, N. Y., Nov. 1966.
- Van der Pol, B., "Forced Oscillations in a Circuit with Nonlinear Resistance," *Philosophical Magazine*, Vol. 3, pp. 65-80, Jan.-June 1927.
- Van der Pol, B., "The Nonlinear Theory of Electric Oscillations," *Proc. IRE*, Vol. 22, pp. 1051-1086, 1934.
- Van der Pol, B., "On Oscillation Hysteresis in a Triode Generator with Two Degrees of Freedom," *Philosophical Magazine*, Vol. 43, pp. 700-719, Jan.-June 1922.
- Van der Pol, B., "Relaxation Oscillations," *Philosophical Magazine*, Vol. 2, pp. 978-992, July-Dec. 1926. Also see "Frequency Demultiplication," *Nature*, Vol. 120, pp. 363-364, Sept. 1920.
- Van Trees, H. L., *Detection, Estimation, and Modulation Theory*, Part I (1968) and Part II (1971), John Wiley & Sons, Inc., New York.
- Van Trees, H. L., "Functional Techniques for the Analysis of the Nonlinear Behavior of Phase-Locked Loops," *Proc. IEEE*, Vol. 52, pp. 894-911, Aug. 1964.
- Van Trees, H. L., "A Lower Bound on Stability in Phase-Locked Loops," *Inform. Contr.*, Vol. 6, pp. 195-212, Sept. 1963.
- Van Trees, H. L., *Optimum Power Division in Coherent Communication Systems*, AD-406 882, Lincoln Lab., M.I.T., Lexington, Mass., Feb. 1963.
- Van Trees, H. L., *A Threshold Theory for Phase-Locked Loops*, Technical Report No. 246, Lincoln Laboratory, Massachusetts Institute of Technology, Aug. 22, 1961.
- Vaughan, G. R., and Osborne, E., "Phase-Locked Phase Modulator," Digest of Technical Papers, *IEEE Int. Commun. Conf.*, pp. 206-207, June 1966.
- Vaughan, G. R., Osborne, E. F., and Entwistle, G. S., *Locked Oscillator Phase Modulator*, Appendix D, Final Report, N65-29140, Defense and Space Center, Westinghouse Elec. Corp., Baltimore, Md., Aug. 25, 1964.

- VCO Stability, Research Summary 36-3, pp. 52-53, Jet Propulsion Laboratory, Pasadena, Calif., June 15, 1960.
- Vehicle Tracking Receiver Design, N66-38787, Motorola, Inc., Scottsdale, Ariz., Aug. 3, 1966.
- Victor, W. K., *The Evaluation of Phase-Stable Oscillators for Coherent Communication Systems*, JPL External Publication No. 337, Jet Propulsion Laboratory, Pasadena, Calif., May 8, 1956.
- Victor, W. K., *Minimum Bandwidths of Phase Lock Loops Using Crystal-Controlled Oscillators*, Jet Propulsion Laboratory, Mar. 15, 1954.
- Victor, W. K., and Brockman, M. H., *The Application of Linear Servo Theory to the Design of AGC Loops*, JPL External Publication No. 586, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 22, 1958. Also *Proc. IRE*, Vol. 48, pp. 234-238, Feb. 1960.
- Viskanta, V. Z., "Compound Phase-Locked Loop Receiver," Records of NTC 69, *National Telemetry Conference*, Washington, D. C., pp. 247-253, Apr. 22-24, 1969.
- Viterbi, A. J., *Acquisition and Tracking Behavior of Phase Locked Loops*, External Publication No. 673, Jet Propulsion Laboratory, Pasadena, Calif., July 1959.
- Viterbi, A. J., "Acquisition and Tracking Behavior of Phase-Locked Loops," *Proceedings of the Symposium on Active Networks and Feedback Systems*, Apr. 1960, Microwave Research Institute Symposia Series, Vol. X, pp. 583-619, Polytechnic Press, 1960.
- Viterbi, A. J., *The Effect of Sinusoidal Interference on Phase-Locked Loops*, JPL Section Report 8-583, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 16, 1959.
- Viterbi, A. J., *Functional Design of Telemetry Discriminators*, Technical Memorandum 8-1, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 1958.
- Viterbi, A. J., "Phase-Locked Loop Dynamics in the Presence of Noise by Fokker-Planck Techniques," *Proc. IEEE*, Vol. 51, pp. 1737-1753, Dec. 1963.
- Viterbi, A. J., "Phase-Lock Loop Systems," in *Space Communications*, pp. 123-142, McGraw-Hill Book Co., Inc., New York, 1963.
- Viterbi, A. J., *Principles of Coherent Communication*, McGraw-Hill Book Co., Inc., New York, 1966.
- Viterbi, A. J., "System Design Criteria for Space Television," *Brit. IRE*, Vol. 19, pp. 561-570, Sept. 1959.
- Viterbi, A. J., and Cahn, C. R., "Optimum Coherent Phase and Frequency Demodulation of a Class of Modulating Spectra," *IEEE Trans. Space Electron. Telem.*, Vol. SET-10, pp. 95-102, 1964.
- Walker, J. R., and Overlander, R., "Oscillator, Phase-Locked, AD-462 369, Space and Inform. Syst. Div., North American Aviation, Inc., Downey, Calif., Apr. 1964.
- Wang, C. C., "An Exact Solution of Injection Phase-Locking," *ITC Proc.*, Washington, D. C., pp. 94-104, Sept. 15-17, 1969.

- Warner, A. W., "Design and Performance of an Ultra Precise 2.5 Mc Quartz-Crystal Unit," *Bell Syst. Tech. J.*, Vol. 34, pp. 1193-1217, Sept. 1960.
- Warren, W. B., "Tracking Notch Filter for the Rejection of CW Interference," *Proc. 9th Tri-Service Conf. Electromagn. Compatibility*, Chicago, Ill., pp. 326-339, Oct. 1963.
- Weaver, C. S., "Designing a Phase-Locked Loop as a Doppler Tracker," *Proc. IRE*, Vol. 50, p. 1992, Sept. 1962.
- Weaver, C. S., "Increasing the Dynamic Tracking Range of a Phase-Locked Loop," *Proc. IRE*, Vol. 4, pp. 952-953, May 1960.
- Weaver, C. S., "A New Approach to the Linear Design and Analysis of Phase-Locked Loops," *Trans. IRE*, Vol. SET-5, pp. 166-178, Dec. 1959.
- Weaver, C. S., *Preliminary Studies of Adaptive Processes Applied to Phase Locked Loops*, WDL-TR-1334, Philco Corp., Sept. 15, 1960.
- Weaver, C. S., "Thresholds and Tracking Ranges in Phase-Locked Loops," *Trans. IRE*, Vol. SET-7, pp. 60-70, Sept. 1961.
- Webb, J. A., "Optimum Demodulation Using Digital Sampled Data," *SWIEEECO Rec.*, pp. 209-213, Apr. 1970.
- Webb, J. A., "A Study in Demodulation Techniques," *Proc. Nat. Electron. Conf.*, 1961.
- Weber, C. L., *A Unified Theory of Coherent Digital Systems Which Track Doppler Frequency*, Interim Technical Report, N71-11297, University of Southern California, Los Angeles, Oct. 1969.
- Wendt, K. R., and Fredendall, G. L., "Automatic Frequency and Phase Control of Synchronization in Television Receivers," *Proc. IRE*, Vol. 31, pp. 7-15, Jan. 1943.
- Westlake, P. R., "Digital Phase Control Techniques," *IRE Trans. Commun. Syst.*, Vol. CS-8, pp. 237-246, Dec. 1960.
- Whitbeck, R. F., *Graphical Analysis of Nonlinear Systems*, Ph.D. dissertation, Cornell University, Ithaca, N. Y., 1964.
- White, E. L. C., *The Pull-In Range of an A.P.C. Loop*, Report RK/94, EMI Research Laboratory, Middlesex, England, Nov. 1955.
- Williams, T. R., *A Note on Phase-Locked Loops in Space Communications*, N67-22749, pp. 111-119, Goddard Summer Workshop, 1966.
- Williams, W. J., "Selection of Phase Sensitive Detectors for Space Radar," *IEEE Trans. Aerosp. Navig. Electron.*, Vol. ANE-11, pp. 230-234, Dec. 1964.
- Williard, M. W., "Analysis of a System of Mutually Synchronized Oscillators," *IEEE Trans. Commun. Technol.*, Vol. COM-18, pp. 467-483, 1970.
- Wilson, C. S., and Warren, W. B., *A Frequency Measuring Spectrum Analyzer*, N66-15724, Eng. Experiment Station, Georgia Institute of Technology, Atlanta, Ga., Nov. 1965.
- Wolff, M. W., "Receiver Design Techniques Cuts Synchronization Time," *Electronics*, pp. 74-78, McGraw-Hill Book Co., Inc., New York, Feb. 1964.

- Woodbury, J. R., "Phase-Locked Loop Pull-In Range," *IEEE Trans. Commun. Technol.*, Vol. COM-16, pp. 184-186, correction: p. 495, 1968; comments: Vol. COM-17, pp. 89-90, 1969.
- Woodman, R., *A Narrow-Band Tracking Filter*, NASA Goddard Space Flight Center, Greenbelt, Md., Jan. 17, 1964.
- Woodman, R. F., *A Phase-Locked Phase Filter for the Minitrack System*, NASA Technical Note D-1419, Goddard Space Flight Center, Sept. 1962.
- Woodyard, J. R., "Application of the Autosynchronized Oscillator to Frequency Demodulation," *Proc. IRE*, Vol. 25, pp. 612-619, 1957.
- Wynn, W. D., *The Optimum Phase Demodulator for Interfering PM Subcarrier Signals*, Bellcomm, Inc., Washington, D. C.
- Yang, J. H., and Wolff, S. S., "A Phase-Locked Loop with Quasi-linear Phase Detector," *Proc. 9th Allerton Conference on Circuit and System Theory*, pp. 349-357, 1969.
- Yang, K. H., "A Study of Capture Bandwidth of Phase Locked Loops with a Non-linear Integrating Filter," *Electron. Mainland China*, Part II, pp. 29-42, 1969.
- Yates, F. F., *Communication Link Performance*, N63-23576, Aerospace Corp., El Segundo, Calif., Aug. 1963.
- Yates, F. F., *Phase-Lock Demodulation of Sinusoidal FM*, Aerospace Corp., El Segundo, Calif., Nov. 20, 1963.
- Yen, C. S., "Phase-Locked Sampling Instruments," *IEEE Trans. Instrum. Meas.*, Vol. IM-14, pp. 64-68, 1965.
- Young, J. R., Reamer, E. D., and Craft, R., "Detection and Measurement of Cycle Skipping and Phase Offsets in Frequency Multiplying Phase-Lock Filters," *IEEE Nat. Space Electron. Symp.*, p. 14, 1963.
- Zaima, Y., *A Phase Lock System for Signal Modulated by a PN Sequence*, Naval Postgraduate School, Monterey, Calif., May 1966.
- Zakheim, J., "Study of the Functioning of Phase-Lock Systems," *Inter-Electronique*, Vol. 21, pp. 28-32, Nov. 1966.
- Zanadvorov, P. N., "On the Synchronization of Oscillators by Periodic Pulse Trains," *Radio Eng. Electron., USSR*, Vol. 3, No. 2, pp. 281-296, 1958.
- Zegers, L. E., "Common Bandwidth Transmission of Information Signals and Pseudonoise Synchronization Waveforms," *IEEE Trans. Commun. Technol.*, Vol. COM-16, No. 6, pp. 796-807, Dec. 1968.
- Ziemer, R. E., *Experimental Comparison of Costas and PLL Demodulators in RFI Environments*, NASA Goddard Space Flight Center, Greenbelt, Md.
- Zrubek, W. E., *Optimum Design of Communication Links with Noisy Phase Reference*, N69-13155, NASA Manned Spacecraft Center, Houston, Tex., Dec. 1968.